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# GeoScience Abstracts

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*published monthly by the*
**AMERICAN GEOLOGICAL INSTITUTE**

## GEOSCIENCE ABSTRACTS

*published by the*
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Alberta Society of Petroleum Geologists, Journal. Calgary, Alberta.
American Association of Petroleum Geologists, Bulletin. Tulsa, Oklahoma.
American Ceramic Society, Journal. Easton, Pennsylvania.
American Geological Institute, AGI Data Sheet; Report. Washington, D. C.
American Journal of Science. New Haven, Connecticut.
American Midland Naturalist. Notre Dame, Indiana.
American Museum of Natural History, Bulletin; Science Guide. New York.
American Society of Civil Engineers, Irrigation and Drainage Division, Journal. New York.
American Society of Civil Engineers, Soil Mechanics and Foundations Division, Journal. New York.
British Columbia Dept. of Mines, Bulletin. Victoria, B. C.
California, Dept. of Water Resources, Bulletin. [Sacramento?].
California, Division of Mines, Bulletin; [Map]; Mineral Information Service; Special Report. San Francisco.
Canada, Dominion Observatory, Publication. Ottawa.
Canada, Geological Survey, Bulletin; Map; Paper. Ottawa.
Canadian Journal of Physics (National Research Council of Canada). Ottawa.
Canadian Journal of Zoology (National Research Council of Canada). Ottawa.
Earth Science. Chicago.
Gems and Minerals. Mentone, California.
Geochimica et Cosmochimica Acta. London - New York.
Geological Society of America, Bulletin; Memoir. New York.
Geophysics (Society of Exploration Geophysicists). Tulsa, Oklahoma.
GeoTimes (American Geological Institute). Washington, D. C.
Illinois State Geological Survey, Circular. Urbana, Illinois.
Iowa Academy of Science, Proceedings. Des Moines, Iowa.
Journal of Geology. Chicago.
Kansas, State Geological Survey, Bulletin. Lawrence, Kansas.
Kentucky Geological Survey, Information Circular; [Map]. Lexington, Kentucky.
Lapidary Journal. Del Mar, California.
Louisiana, Geological Survey, Water Resources Pamphlet. Baton Rouge, Louisiana.
Micropaleontology (American Museum of Natural History). New York.
Military Engineer (Society of American Military Engineers). Washington, D. C.
Mineral Industries (Pennsylvania State University, College of Mineral Industries). University Park, Pennsylvania.
Mineral Industries Journal (Virginia Polytechnic Institute). Blacksburg, Virginia.
National Academy of Sciences, Proceedings. Washington, D. C.
National Academy of Sciences-National Research Council, Publication. Washington, D. C.
National Research Council, Highway Research Board, Bulletin. Washington, D. C.
National Speleological Society, Bulletin. Alexandria, Virginia.
National Speleological Society, Washington Speleological Survey, Bulletin. [n. p.]
New Mexico, Bureau of Mines and Mineral Resources, Circular. Socorro, New Mexico.
New York State Museum and Science Service, Geological Survey, Newsletter. Albany, New York.
New York, Water Power and Control Commission, Bulletin. Albany, New York.
Northwest Science (Northwest Scientific Association). Cheney, Washington.
Ohio, Division of Water, Technical Report. Columbus, Ohio.
Oilweek. Calgary, Alberta.
Oklahoma Academy of Science, Proceedings. Norman, Oklahoma.
Oklahoma Geology Notes (Oklahoma Geological Survey). Norman, Oklahoma.
Ontario Dept. of Mines, Annual Report. Toronto.
Photogrammetric Engineering (American Society of Photogrammetry). Washington, D. C.
Quebec (Province), Dept. of Mines, Preliminary Report. Quebec.
Rocks and Minerals. Peekskill, New York.
Science. Washington, D. C.
Scientific American. New York.
South Carolina, State Development Board, Division of Geology, Geologic Notes. Columbia, South Carolina.
South Dakota, State Geological Survey, Circular; Geologic Quadrangle Map Series; Minerals Report; Oil and Gas Investigations, Map. Vermillion, South Dakota.
Southern California Academy of Sciences, Bulletin. Los Angeles, California.
Texas Journal of Science. Austin, Texas.
Texas, University, Publication. Austin, Texas.
U. S. Geological Survey, Bulletin; Geologic Quadrangle Map; Geophysical Investigations Map; Mineral Investigations Map; Miscellaneous Investigations Map; Reports, Open-File Series; Trace Elements Investigations Report; Water-Supply Paper. Washington, D. C.
U. S. Snow, Ice and Permafrost Research Establishment, Translation. Wilmette, Illinois.
Vermont Geological Survey, Bulletin. Montpelier, Vermont.
Virginia Journal of Science (Virginia Academy of Science). Farmville, Virginia.
Washington, Division of Mines and Geology, Information Circular. Olympia, Washington.
World Oil. Houston, Texas.
World Petroleum. New York.
Yale University, Peabody Museum of Natural History, Postilla. New Haven, Connecticut.

# GeoScience Abstracts

## 1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

### PART 1. GEOLOGIC MAPS

See also: Mineral Deposits 2-967.

2-782. Pelletier, B.R. GEOLOGY, TETSA RIVER, PEACE RIVER DISTRICT, BRITISH COLUMBIA: Canada, Geol. Survey, Map 29-1959, scale 1:63,360, marginal notes, 3 secs., 2 diags., 1959.

Preliminary series geological map covering about 300 sq. mi. situated on Alaska Highway about 75 mi. W. of Fort Nelson. Devonian, Mississippian, Permian(?) and Cretaceous rocks are exposed in 3 major physiographic subdivisions: 1) plains region in NE. corner, characterized by high buttes and mesas of Cretaceous sandstones; 2) the foothills belt, consisting of an eastern half of low rolling hills underlain by Cretaceous shales and a western part of folded Paleozoic and Triassic strata trending northwesterly; and 3) front ranges of Rocky Mountains in SW., composed of Paleozoic rocks dissected by streams and glaciers into alpine forms. Ripple mark studies of Triassic sediments, exposed as a rose diagram, permit interpretation of shore zone trends and sedimentation belts during middle Triassic times, and these features are shown in a small marginal sketch map. --P. Harker.

2-783. Neale, E.R.W. GEOLOGY, FLEUR DE LYS, NEWFOUNDLAND: Canada Geol. Survey, Map 16-1959, scale 1:63,360, marginal notes. 1959, 4 refs.

Approximately 85% of the map-area is underlain by the Fleur de Lys group, formerly classified as Precambrian. The remainder is underlain by the Ordovician(?) Baie Verte group and associated ultrabasic and dioritic rocks. The Fleur de Lys group consists largely of leucocratic biotite-muscovite-quartz-plagioclase schists and gneisses with local layers of mafic schist and feldspathic quartzite. Garnetiferous schists and gneisses appear to constitute a distinct stratigraphic unit. Graphite schist layers and thin sills of metagabbro occur in both garnet-free and garnetiferous units.

The Baie Verte group consists largely of greenschist grade andesite and basalt with associated pyroclastic rocks and minor thin beds of graywacke and graphitic slate. Epidotic hornblende-chlorite schists and gneisses are included in the Baie Verte group because typical Baie Verte rocks merge with them along strike. These rocks are conformably intercalated with Fleur de Lys gneisses in several places, and this relationship suggests that the Fleur de Lys group may be lower Paleozoic instead of Precambrian as hitherto concluded.

Small plutons of serpentinized ultrabasic rocks intrude both groups. Metadiorite and metagabbro, locally pseudostratified, are spatially associated with the ultrabasic rocks.

The area is characterized by NE. and NNE. strikes. The fault system includes steeply-dipping NE.- and NW.-striking faults. In general, the NW.-striking faults are younger.

Old Cu, molybdenite, and Pb-Zn prospects are located in the vicinity of Fleur de Lys village. Newly mapped ultrabasic bodies should be prospected for asbestos and chromite.--Auth.

2-784. Canada, Geological Survey. GEOLOGY, AXEL HEIBERG AND STOR ISLANDS, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES: Its: Map 36-1959, scale 1:506,880, 1959.

Preliminary series geological map of a large island just W. of Ellesmere Island and extending up to 81°30'N. Axel Heiberg Island lies at the eastern end of the Sverdrup sedimentary basin and consists of an essentially conformable sequence of marine and nonmarine rocks of Pennsylvanian, Permian, Triassic, Jurassic, Cretaceous, and Tertiary rocks intruded by gabbro sills probably of Cretaceous age. Basic lavas of Permian age occur in the N. and of Cretaceous age in the W. A belt of folding affects most of Axel Heiberg Island and trends just W. of N. The central region is mountainous, with numerous permanent ice caps and glaciers, and much of it remains unmapped.--P. Harker.

2-785. Hoare, Joseph M., and Warren L. Coonrad. GEOLOGY OF THE BETHEL QUADRANGLE, ALASKA: U.S. Geol. Survey, Misc. Inv. Map I-285, scale 1:250,000, lat. 60°-61°N., long. 159°-162°W., 1959, pub. 1960.

This map shows the geology of about 7,000 sq. mi. in SW. Alaska, S. of the Kuskokwim River and W. of the Tikchik Lakes. The map shows the structure and distribution of rock units ranging in age from Precambrian to Quaternary and is accompanied by a brief description of the rock units.--U. S. Geol. Survey.

2-786. Jennings, Charles W., and Rudolph G. Strand, comps. GEOLOGIC MAP OF CALIFORNIA: SANTA CRUZ SHEET: California, Div. Mines, scale 1:250,000, contour intervals 100 and 200 ft., 2 sheets: geol. map, strat. nomenclature, illus., 1959, 36 refs.

The fourth sheet in the Geologic Map of California series covers the area bounded by 36°-37°N., 120°-122°12' W. It includes all of San Benito County, and portions of Monterey, Fresno, Kings, Santa Cruz, Santa Clara, Merced, and Madera counties. The area extends from the Pacific coast to central San Joaquin Valley and includes parts of the Santa Lucia, Gabilan, and Diablo mountain ranges, and portions, or all, of Salinas, Santa Clara, Panoche, Pleasant, and San Joaquin valleys.

Thirty-six different map symbols have been used to depict the wide variety of rock units that range in age from pre-Cretaceous (Sur series) to Recent (dune sand and alluvium).

A number of interesting and significant features are graphically portrayed by the map. These include the San Andreas fault zone, the syncline of the Vallecitos area, the anticline of the N. dome of Kettleman Hills, the serpentine of the New Indria area, the volcanic rocks of the Pinnacles National Monument area, and offshore submarine topography.

An explanatory data sheet accompanies the map sheet. It describes the sources from which the map was compiled, explains the grouping of the stratigraphic units which comprise the various time-stratigraphic state map units, and contains an index of topographic quadrangles.--Auth.

2-787. Jennings, Charles W., comp. GEOLOGIC MAP OF CALIFORNIA: SANTA MARIA SHEET: California, Div. Mines, scale 1:250,000, contour intervals 100 and 200 ft., 2 sheets: geol. map, strat. nomenclature, 2 illus., 1959, 9 refs.

The fifth sheet of the new State Geologic Map of California covers the area of the western half of Santa Barbara County and includes the Santa Rosa and San Miguel islands. Prominent physiographic features include the western Santa Ynez Mountains, Santa Maria Valley, and part of the San Rafael Mountains.

Twenty-two of the 105 state geologic map units appear on the Santa Maria sheet. These units include 6 Quaternary, 2 Pliocene, 5 Miocene, 2 Oligocene, 1 Eocene, 5 Cretaceous, and 1 Jurassic. Marine sedimentary, nonmarine sedimentary, volcanic, and intrusive rocks are differentiated.

A number of interesting and significant geologic features are strikingly portrayed by the map. Some of these include the Santa Ynez, Suey, Pacifico, and Honda faults, the Huasna syncline, the S.-dipping homocline of Tertiary and Cretaceous strata in the Santa Ynez Range, the Santa Rosa Island lateral fault, the San Juan seamount, and the Patton escarpment.

The most important mineral resource of the map area is petroleum from the Capitan field on the S. coast and a number of fields in the Santa Maria basin. The Johns-Manville quarries in the Sisquoc formation S. of Lompoc are said to be the largest diatomite quarries in the world. Oil-saturated diatomaceous Sisquoc shale near Casmailia, provides the raw material for the lightweight aggregate industry.

Accompanying the geologic map sheet is an explanatory data sheet containing a source data index, a stratigraphic nomenclature chart, and 2 aerial oblique photographs.--Auth.

2-788. Crawford, Thomas J. OIL AND GAS MAP, LARUE COUNTY, KENTUCKY: Kentucky Geol. Survey, Ser. 10, scale 1:48,000, Sept. 1959.

This map was prepared primarily to show the general trend of oil and gas exploration and development in the area, and for use as a tool in further exploration. One hundred and seventy-one wells are located and identified by farm name; operator, elevation, and total depth of the wells are given where known. A general outline of the Magnolia gas field, with wells in LaRue, Hart, and Green counties, is included. The base map of LaRue County was adapted from recent U. S. Geological Survey 7. 5-min. planimetric sheets and provides an accurate base for continuing oil and gas investigation in the county and for posting new data as it becomes available.--Auth.

2-789. Rose, William D. OIL AND GAS MAP, MUHLENBERG COUNTY, KENTUCKY: Kentucky Geol. Survey, Ser. 10, scale 1:48,000, Aug. 1959.

This map was prepared primarily to show the general trend of oil and gas exploration and development in the area, and for use as a tool in further exploration. Sixteen hundred and sixteen wells are located and identified by farm name; operator, elevation, and total depth of the wells are given where known. Oil and gas pools are named, and producing horizons indicated. The base map of Muhlenberg County was adapted from recent U. S. Geological Survey 7.5-min. planimetric sheets and provides an accurate base for continuing oil and gas investigation in the county and for posting new data as it becomes available.--T. J. Crawford.

2-790. James, Harold L., Carl E. Dutton, F.J. Pettijohn, and Kenneth Leland Wier. GEOLOGIC MAP OF THE IRON RIVER-CRYSTAL FALLS DISTRICT, IRON COUNTY, MICHIGAN: U.S. Geol. Survey, Mineral Inv. Map MF-225, 3 sheets, scale 1:24,000, lat. 46°-46°07'30"N., long. 88°15'-88°45' 1959, pub. 1960.

This map (in 2 sheets) is of an area of about 300 sq. mi. in Iron County, in the northern peninsula of Michigan. The rocks are mostly Precambrian in age; they include several Fe formations from which Fe ore is being or has been produced. The map shows contoured magnetic data, and the accompanying explanation sheet contains a stratigraphic chart. --U. S. Geol. Survey.

2-791. Bromery, Randolph W., John R. Henderson, Jr., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE BIRDSBORO QUADRANGLE, BERKS COUNTY, PENNSYLVANIA: U.S. Geol Survey, Geophys. Inv. Map GP-231, scale 1:24,000, contour interval 50 gammas, lat. 40°15'-40°22'30"N. long 75°45'-75°52'30"W., 1960.

2-792. Bromery, Randolph W., Gerald L. Zandle and others. AEROMAGNETIC MAP OF THE BOYERTOWN QUADRANGLE, BERKS AND MONTGOMERY COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-232, scale 1:24,000, contour interval 50 gammas, lat. 40°15'-40°22'30"N., long. 75°37'30"-75°45'W., 1960.

2-793. Bromery, Randolph W., John R. Henderson, Jr., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF PART OF THE COATESVILLE QUADRANGLE, CHESTER COUNTY, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-22 scale 1:24,000, contour interval 50 gammas, lat. 39°52'30"-40°N., long. 75°45'-75°52'30"W., 1960.

2-794. Bromery, Randolph W., Gerald L. Zandle and others. AEROMAGNETIC MAP OF THE DOWNINGTOWN QUADRANGLE, CHESTER COUNTY, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-224, scale 1:24,000, contour interval 50 gammas, lat. 40°-40°07'30"N., long. 75°37'30"-75°45'W., 1960.

2-795. Bromery, Randolph W., John R. Henderson, Jr., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF PART OF THE EASTON QUADRANGLE, NORTHAMPTON COUNTY, PENNSYLVANIA, AND WARREN COUNTY, NEW JERSEY: U.S. Geol Survey, Geophys. Inv. Map GP-235, scale 1:24,000, contour interval 50 gammas, lat. 40°37'30"-40°45'N long. 75°07'30"-75°15'W., 1960.

2-796. Bromery, Randolph W., John R. Henderson, Jr., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE FLEETWOOD QUADRANGLE, BERKS COUNTY, PENNSYLVANIA: U.S. Geo Survey, Geophys. Inv. Map GP-228, scale 1:24,000, contour interval 50 gammas, lat. 40°22'30"-40°30'N long. 75°45'-75°52'30"W., 1960.

2-797. Bromery, Randolph W., John R. Henderson, Jr., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF PART OF THE HATBORO QUADRANGLE, BUCKS, MONTGOMERY, AND PHILADELPHIA COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-237, scale 1:24,000, contour interval 50 gammas, lat. 40°07'30 40°15'N., long. 75°-75°07'30"W., 1960.

2-798. Bromery, Randolph W., John R. Henderson, Jr., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE HONEY BROOK QUADRANGLE, CHESTER AND LANCASTER COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-233, scale 1:24,000, contour interval 50 gammas, lat. 40°-40°07'30"N., long. 75°52'30"-76°N., 1960.

2-799. Bromery, Randolph W., John R. Henderson, Jr., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE LANGHORNE QUADRANGLE, BUCKS COUNTY, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-238, scale 1:24,000, contour interval 50 gammas, lat. 40°07'30"-40°15'N., long. 74°52'30"-75°W., 1960.

2-800. Bromery, Randolph W., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE MANATAWNEY QUADRANGLE, BERKS COUNTY, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-229, scale 1:24,000, contour interval 50 gammas, lat. 40°22'30"-40°30'N., long. 75°37'30"-75°45'W., 1960.

2-801. Bromery, Randolph W., John R. Henderson, Jr., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE PARKESBURG QUADRANGLE, CHESTER AND LANCASTER COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-234, scale 1:24,000, contour interval 50 gammas, lat. 39°52'30"-40°N., long. 75°52'30"-76°W., 1960.

2-802. Bromery, Randolph W., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE POTTSTOWN QUADRANGLE, BERKS, CHESTER, AND MONTGOMERY COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-222, scale 1:24,000, contour interval 50 gammas, lat. 40°07'30"-40°15'N., long. 75°37'30"-75°45'W., 1960.

2-803. Bromery, Randolph W., John R. Henderson, Jr., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE READING QUADRANGLE, BERKS COUNTY, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-230, scale 1:24,000, contour interval 50 gammas, lat. 40°15'-40°22'30"N., long. 75°52'30"-76°W., 1960.

2-804. Bromery, Randolph W., John R. Henderson, Jr., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF PART OF THE RIEGELSVILLE QUADRANGLE, BUCKS AND NORTHAMPTON COUNTIES, PENNSYLVANIA, AND HUNTERDON AND WARREN COUNTIES, NEW JERSEY: U.S. Geol. Survey, Geophys. Inv. Map GP-236, scale 1:24,000, contour interval 50 gammas, lat. 40°30'-40°37'30"N., long. 75°07'30"-75°15'W., 1960.

2-805. Bromery, Randolph W., John R. Henderson, Jr., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE TEMPLE QUADRANGLE, BERKS COUNTY, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-227, scale 1:24,000, contour interval 50 gammas, lat. 40°22'30"-40°30'N., long. 75°52'30"-76°W., 1960.

2-806. Bromery, Randolph W., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF PART OF THE UNIONVILLE QUADRANGLE, CHESTER COUNTY, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-226, scale 1:24,000, contour interval 50 gammas, lat. 39°52'30"-40°N., long. 75°37'30"-75°45'W., 1960.

2-807. Bromery, Randolph W., John R. Henderson, Jr., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE WAGONTOWN QUADRANGLE, CHESTER COUNTY, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-223, scale 1:24,000, contour interval 50 gammas, lat. 40°-40°07'30"N., long. 75°45'-75°52'30"W., 1960.

2-808. Collins, Sam G. GEOLOGY OF THE MARTIN QUADRANGLE, SOUTH DAKOTA: South Dakota, State Geol. Survey, Geol. Quad. Map Ser., col. map, scale 1:62,500, text on reverse of map sheet, 1959, ref.

The quadrangle is in the S.-central part of the state, in the Missouri plateau section of the Great Plains physiographic province. It was mapped on air photos as part of a program to map the economic geology of this part of the state. The treatment of the subject matter is brief.

The Arikaree formation which includes the Monroe Creek and Harrison members, is a Miocene fluviatile and lacustrine deposit. It is present throughout the area and is overlain in the southern third of the quadrangle by the Pliocene Valentine formation. The Valentine formation is overlain by the Quaternary Sand Hills formation.

Unconsolidated surficial deposits in the area include alluvial and colluvial material in the stream valleys and an indistinct terrace deposit along the Little White River and its main tributary, Lake Creek.

In the subsurface the Pierre shale, Niobrara marl, Carlile shale, Greenhorn limestone, Belle Fourche-Mowry shales, Newcastle-Morrison sandstone and shale, Opeche shale, and Minnelusa sandstone are recognized from English #1 Kocer oil test.

Economic products in the quadrangle include ground water of good quality, which is available throughout the area, and sand and gravel in small quantities. Oil and gas, clay minerals, volcanic ash, and U may be potentially economic.--M. J. Tipton.

2-809. Sevon, William D. GEOLOGY OF THE OKREEK QUADRANGLE, SOUTH DAKOTA: South Dakota, State Geol. Survey, Geol. Quad. Map Ser., col. map, scale 1:62,500, text on reverse of map sheet, 1959, 2 refs.

The quadrangle is in the S.-central part of the state, in the Missouri plateau section of the Great Plains physiographic province. It was mapped on air photos as part of a study of the economic geology of this and surrounding areas. The treatment of the subject matter is brief.

Pierre shale, a marine deposit of Cretaceous age, is present throughout the quadrangle and is overlain in the western and southern parts by Tertiary fluviatile and lacustrine sediments of Oligocene, Miocene, and Pliocene age. The Oligocene White River strata consist of silty claystone, siltstone, sandstone, gravel, and bentonite. The Miocene Arikaree strata, which includes the Mellette limestone facies, consist of claystone, sandstone, and limestone. The Pliocene Ogallala sediments, which include the Valentine and Ash Hollow formations and the Bijou quartzite facies, consist of unconsolidated sands, sandstone, and quartzitic sandstone.

Unconsolidated surficial deposits in the area include alluvium, colluvium, and an upper and lower terrace deposit, all along the present streams or along old channel deposits.

In the subsurface the Pierre shale, Niobrara chalk, Carlile shale, Greenhorn limestone, Graneros shale, Newcastle sandstone, Skull Creek shale, Fall River-Fuson-Lakota sandstone and shale, Morrison shale, Spearfish shale, Minnelusa sandstone, Red River dolomite, Winnipeg shale and sand, and the Precambrian granite are recognized from 2 well logs.

Economic productions in the quadrangle include ground water, limited quantities of poor quality sand and gravel, thin limestone layers, and quartzitic sandstone. Bentonitic shale and oil and gas are potentially economic.--M. J. Tipton.

**2-810.** Steece, Fred V. **GEOLOGY OF THE HARTFORD QUADRANGLE, SOUTH DAKOTA: South Dakota, State Geol. Survey, Geol. Quad. Map Ser., col. map, scale 1:62,500, text on reverse of map sheet, 1959, 14 refs.**

The quadrangle is located at the southern edge of the Coteau des Prairies in the Big Sioux River basin of eastern South Dakota. It was mapped as part of a program to study the geology and water resources of the river basin. Special emphasis is placed on the Pleistocene deposits because they constitute the major source of shallow ground water. The treatment of the subject matter is brief.

The geology was mapped on air photos. Jeep-mounted auger drills and resistivity surveys were used to determine the thicknesses of water-bearing sand and gravel deposits.

The surficial deposits in the quadrangle consist chiefly of Pleistocene glacial drift in which deposits of the Cary subdivision of the Wisconsin stage are recognized as well as pre-Wisconsin drift of the Illinoian stage. This is the first time that the Illinoian has been mapped areally as a drift sheet in South Dakota.

Sioux formation (Precambrian) underlies the mapped area, and its quartzite is exposed at the surface in several small outcrops in the SE. and the NW. parts of the quadrangle. No sedimentary rocks younger than the Sioux formation are known in the quadrangle.

An estimated 562,000,000 cu. yds. of sand and gravel is present in outwash terrace and valley train deposits along the major drainage ways. These sands and gravels contain an estimated 88,700 acre-ft. of water, most of which is available for industrial, domestic, and irrigation use. The water is generally of good quality.--M. J. Tipton.

**2-811.** Steece, Fred V. **GEOLOGY OF THE SIOUX FALLS QUADRANGLE, SOUTH DAKOTA: South Dakota, State Geol. Survey, Geol. Quad. Map Ser., col. map, scale 1:62,500, text on reverse of map sheet, 1959, 17 refs.**

The quadrangle is located on the southern edge of the Coteau des Prairies in the Big Sioux River basin of eastern South Dakota. It was mapped as part of a program to study the geology and water resources of the river basin. Special emphasis is placed on the Pleistocene deposits because they constitute the major source of shallow ground water. The treatment of the subject matter is brief.

The geology was mapped on air photos. Jeep-mounted auger drills and resistivity surveys were used to determine thicknesses of water-bearing sand and gravel deposits.

The surficial deposits in the quadrangle consist chiefly of Pleistocene glacial drift in which drift of the Cary and Iowan subdivisions of the Wisconsin stage are recognized as well as pre-Wisconsin drift of the Illinoian stage. This marks the first time that the Illinoian has been mapped areally as a drift sheet in South Dakota.

The Precambrian Sioux formation underlies the mapped area and crops out in the eastern and southern parts of the quadrangle. It is intruded by the Precambrian Corson diabase. Rocks of possible Cretaceous and Tertiary age may be present above the Sioux formation in some parts of the area.

An estimated 1,300,000,000 cu. yds. of sand and gravel is present in outwash terrace and valley train deposits along the major drainage ways. These sands and gravels contain an estimated 108,000 acre-ft. of water, most of which is available for domestic, municipal, industrial, and irrigation use. The water is generally of good quality.--M. J. Tipton.

**2-812.** Stevenson, Robert E. **GEOLOGY OF THE DALLAS QUADRANGLE, SOUTH DAKOTA: South Dakota, State Geol. Survey, Geol. Quad. Map Ser., col. map, scale 1:62,500, text on reverse of map sheet, 1959, 12 refs.**

The quadrangle is in the S.-central part of the state, in the prairie lands of the Great Plains physiographic province. It was mapped on air photos as part of a program to study South Dakota's economic mineral resources. The treatment of the subject matter is brief.

Oligocene White River and Pliocene Ogallala sandy fluviatile and lacustrine deposits are present in the central part of the area, and the underlying Late Cretaceous Pierre marine shale is present in the N. and S. parts of the area. The Brule is the only formation of the White River group present in this area. The Ogallala group is divided into the Valentine and Ash Hollow formations and the Bijou quartzitic facies.

The unconsolidated surficial deposits in the quadrangle include sands of the Pleistocene Herrick formation in the upland and Recent alluvial materials along stream valleys.

Rocks not exposed at the surface in the quadrangle but probably present in the subsurface are the Pierre, Niobrara, Carlile, Greenhorn, Belle Fourche, Mowry, Newcastle ("Dakota"), and Skull Creek formations, the Inyan Kara group, the Sundance, Minnelusa, and Red River formations, and Precambrian granite.

Ground water is the principal mineral resource in the area, with sandstone, sand, and gravel also having been produced. Oil and gas, shale, and U are economic mineral resources possibly present in this region.--M. J. Tipton.

**2-813.** Tipton, Merlin J. **GEOLOGY OF THE CHESTER QUADRANGLE, SOUTH DAKOTA: South Dakota, State Geol. Survey, Geol. Quad. Map Ser., col. map, scale 1:62,500, text on reverse of map sheet, 1959, 17 refs.**

The quadrangle is located on the Coteau des Prairies in the Big Sioux River basin of eastern South Dakota. It was mapped as part of a larger program to study the geology and water resources of the river basin. Special emphasis is placed on the Pleistocene deposits because they constitute the ma-

or source of shallow ground water. The treatment of the subject matter is brief.

The geology was mapped on air photos. Jeep-mounted auger drills and resistivity surveys were used to determine thicknesses of water-bearing sand and gravel deposits.

The surficial deposits in the quadrangle consist chiefly of Pleistocene glacial drift in which drift of the Cary and Iowan subdivisions of the Wisconsin stage are recognized as well as pre-Wisconsin drift of the Illinoian stage. This is the first time that the Illinoian has been mapped areally as a drift sheet in South Dakota. In the subsurface the Cretaceous Graneros(?) shale, Dakota(?) sandstone, Fuson(?) shale, and Lakota(?) sand are recognized from drillers' logs. The entire area is underlain by the Precambrian Sioux formation which crops out in 2 small areas in the E.-central part of the quadrangle.

An estimated 555,500,000 cu. yds. of sand and gravel is present in shallow outwash deposits along the major drainage ways. These outwash sands and gravels contain an estimated 63,000 acre-ft. of water, most of which is available for domestic, municipal, industrial, or irrigation use. The quality of the water varies locally from good to very poor.--Auth.

2-814. Tipton, Merlin J. GEOLOGY OF THE DELL RAPIDS QUADRANGLE, SOUTH DAKOTA: South Dakota, State Geol. Survey, Geol. Quad. Map Ser., col. map, scale 1:62,500, text on reverse of map sheet, 1959, 15 refs.

The quadrangle is located on the Coteau des Prairies in the Big Sioux River basin of eastern South Dakota. It was mapped as part of a program to study the geology and water resources of the river basin. Special emphasis is placed on the Pleistocene deposits because they constitute the major source of shallow ground water. The treatment of the subject matter is brief.

The geology was mapped on air photos. Jeep-mounted auger drills and resistivity surveys were used to determine thicknesses of water-bearing sand and gravel deposits.

The surficial deposits in the quadrangle consist chiefly of Pleistocene glacial drift in which drift of the Cary, Tazewell, and Iowan subdivisions of the Wisconsin stage are recognized as well as pre-Wisconsin drift of the Illinoian stage. This is the first time that the Illinoian has been mapped areally as a drift sheet in South Dakota. In the subsurface the Cretaceous Graneros(?) shale, Dakota(?) sandstone, Fuson(?) shale, and Lakota(?) sand are recognized from drillers' logs. The entire area is underlain by the Precambrian Sioux formation which crops out in the southwestern part of the quadrangle.

An estimated 595,000,000 cu. yds. of sand and gravel is present in shallow glacial outwash deposits along the major drainage ways. These outwash sands and gravels contain an estimated 50,500 acre-ft. of water, most of which is available for domestic, industrial, or irrigation use. The quality of the water varies locally from good to very poor.--Auth.

-815. Agnew, Allen F. OIL AND GAS TESTS IN OUTH DAKOTA, 1958: South Dakota, State Geol. urvey, Oil & Gas Inv. Map 3, scale 1:1,000,000, text on reverse of map sheet, 1959.

The map shows the location of the 15 wells drilled in the state during 1958 and by symbol indicates roducing wells, dry holes, oil shows, gas shows, and total depth. Two of the 15 wells drilled were producers, both in the NW. corner of the state. The total footage drilled in 1958 was 44,575 ft., only 28% of 1957. On the back of the map, electric log and sample tops are tabulated for all 15 tests.--M. J. Tipton.

2-816. Petsch, Bruno C. MAGNETOMETER MAP, CORSON, DEWEY AND ZIEBACH COUNTIES, SOUTH DAKOTA: South Dakota, State Geol. Survey, Oil & Gas Inv. Map 4, scale approx. 1:350,000, text on reverse of map sheet, 1959, 8 refs.

The area surveyed is in N.-central South Dakota. Mapping was undertaken as part of a program to survey the entire state. The treatment of the subject matter is brief.

The map shows vertical magnetic anomalies with a contour interval of 100 gammas. The area has 3 prominent N.-S.-trending anomalies: 1) a high on the W. edge of the area, 2) a high on the E. part of the area, and 3) a low between these two. The general slope of the mean magnetic profile corresponds roughly with the regional dip.--M. J. Tipton.

2-817. Cattermole, J.M. GEOLOGY OF THE BEARDEN QUADRANGLE, TENNESSEE: U.S. Geol. Survey, Geol. Quad. Map GQ-126, scale 1:24,000, contour interval 20 ft., lat. 35°52'30"-36°N., long. 84°-84°07'30"W., 1960.

The Bearden quadrangle, an area of 60.4 sq. mi. is just W. of the city of Knoxville. Bedrock within the quadrangle consists of sedimentary rocks ranging in age from Early Cambrian to Middle Ordovician. Thick residual soils generally mantle the rocks of higher carbonate content. Northeastward-trending faults and folds, typical of the southern Appalachian region, and the stratigraphy of the area are described.-- U. S. Geol. Survey.

2-818. Lovering, T.S., and others. GEOLOGIC AND ALTERATION MAPS OF THE EAST TINTIC DISTRICT, UTAH: U.S. Geol. Survey, Mineral Inv. Map MF-230, 2 sheets, scale 1:9,600, lat. 39°55'-40°N., long. 112°-112°05'30"W., 1960.

A colored geologic map shows the distribution of the Paleozoic sedimentary rocks and Eocene igneous rocks without distinguishing the altered areas; another colored map shows types of alteration without distinguishing the geologic formations. The black line geologic base is common to both maps and makes cross reference easy. The relation of intrusions, alteration, structure, and mineral deposits is of great practical and theoretical importance; these maps afford an over-all picture of these relations.-- U. S. Geol. Survey.

2-819. Marshall, C.H. PHOTOGEOLOGIC MAP OF THE CROOKS CREEK SE QUADRANGLE, FREMONT AND SWEETWATER COUNTIES, WYOMING: U.S. Geol. Survey, Misc. Inv. Map I-304, scale 1:24,000, lat. 42°15'-42°22'30"N., long. 107°45'-107°52'30"W., 1959, pub. 1960.

2-820. Marshall, C.H. PHOTOGEOLOGIC MAP OF THE CROOKS CREEK SW QUADRANGLE, FREMONT AND SWEETWATER COUNTIES, WYOMING: U.S. Geol. Survey, Misc. Inv. Map I-305, scale 1:24,000, lat. 42°15'-42°22'30"N., long. 107°52'30"-108°W., 1959, pub. 1960.

2-821. Marshall, C.H. PHOTOGEOLOGIC MAP OF THE SPLIT ROCK SW QUADRANGLE, FREMONT AND SWEETWATER COUNTIES, WYOMING: U.S. Geol. Survey, Misc. Inv. Map I-306, scale 1:24,000, lat. 42°15'-42°22'30"N., long. 107°37'30"-107°45'W., 1959, pub. 1960.

2-822. Olson, A.B. PHOTOGEOLOGIC MAP OF THE FLAT TOP MOUNTAIN NE QUADRANGLE, CARBON COUNTY, WYOMING: U.S. Geol. Survey, Misc. Inv. Map I-301, scale 1:24,000, lat. 41°07'30"-41°15'N., long. 107°45'-107°52'30"W., 1959, pub. 1960.

## PART 2. AREAL AND REGIONAL GEOLOGY

See also: Geophysics 2-904; Geohydrology 2-955; Mineral deposits 2-969, 2-970, 2-971.

2-823. Fyles, James T., and C.G. Hewlett. STRATIGRAPHY AND STRUCTURE OF THE SALMO LEAD-ZINC AREA: British Columbia Dept. Mines, Bull. no. 41, 162 p., 20 figs. (9 in separate envelope) incl. 16 illus., geol. map, scale 1:24,000, 1959, 29 refs.

The Salmo Pb-Zn area is in southeastern British Columbia near the southern end of the Kootenay arc. The Kootenay arc is a belt of sedimentary and metamorphic rocks extending SE. from Revelstoke, S. along Kootenay Lake, and SW. across the International Boundary.

Detailed studies of 4 conformable Cambrian formations - the Quartzite Range, Reno, Laib, and Nelway - have been made. The Quartzite Range and Reno are dominantly quartzitic, the Laib is an argillaceous formation containing prominent limestone members, and the Nelway is a thick unit of limestone. Black argillite of the Active formation of Ordovician age overlies the Nelway formation with probable disconformity.

The map area is structurally very complex. Overturned and isoclinal folds called "primary" are the oldest known structures. These folds have been folded into structures called "secondary." Bedding and thrust faults probably originated late in the period of primary folding and continued to be active during the secondary folding. Granitic stocks cut the primary and secondary structures. Complex folds around the margins of some of these stocks are referred to as late cross-folds. Transverse faults offset the primary and secondary structures and some offset the late cross-folds.

The principal Pb-Zn deposits are replacements of sphalerite, galena, and pyrite in dolomitized zones in a limestone member of the Laib formation. Dolomitization and sulfide mineralization are structurally controlled. Many of the ore bodies and dolomite zones follow secondary folds, and some zones of the sulfides follow bedding faults. Dolomitization preceded sulfide mineralization, and dolomite acted as a favorable host rock.--J. T. Fyles.

2-824. Thorsteinsson, R., and E.T. Tozer. WESTERN QUEEN ELIZABETH ISLANDS, DISTRICT OF FRANKLIN, NORTHWEST TERRITORIES: Canada, Geol. Survey, Paper 59-1, 7 p., Map 13-1959 (in pocket), scale 1:506,880, 1959, 9 refs.

Area covers Melville, Prince Patrick, Mackenzie King and Borden islands. Much of Melville Island lies within the Parry Islands fold belt and consists of mainly symmetrical E.-W. folds of Ordovician, Silurian, and Devonian rocks. The central part of the area forms part of the Sverdrup basin; 5 other lesser provinces of distinct structural regions are recognized. Pennsylvanian rocks overlie eroded surface of the older, folded rocks. Angular unconformity between Pennsylvanian and Permian occurs in some places; elsewhere they are conformable, and within the Sverdrup basin there is an essentially conformable sequence from Permian to Upper Cretaceous. Igneous rocks consist of minor gabbroic masses and dikes. Surficial deposits comprise ridges of glacial till on southern Melville Island; exotic boulders show that glaciers crossed Viscount Melville Sound and extended on to the Queen Elizabeth Islands. --P. Harker.

2-825. Hewitt, D.F. GEOLOGY OF CARDIFF AND FARADAY TOWNSHIPS: Ontario Dept. Mines, Ann. Rept., v. 66, pt. 3, 1957, 82 p., illus., 3 geol. maps (1 in pocket, scale 1:31,680), tables, pub. 1959, refs.

The 2 townships cover about 214 sq. mi. in the center of the Haliburton-Bancroft U district. The present geological survey was carried out in summers 1954-1955. During 1953-1956 a large number of U prospects were opened up.

The bedrock formations are all Precambrian and consist of an old series of Grenville metasedimentary rocks intruded and replaced by basic and acid plutonic rocks (diorite, gabbro, granite, syenite, and nepheline syenite). Two geological divisions are recognized: 1) the Haliburton and Hastings highland gneiss complex lying to the N. and W., making up most of Cardiff township and northern Faraday township; 2) the Hastings basin, occupying the SE. corner of Cardiff township and the southern part of Faraday township. The first division is a terrane of ultrametamorphic gneisses, characterized by rocks of the amphibolite-granulite facies, modified by metasomatism, granitization, injection, and intrusion, and dominated by emplacement of granitic batholiths, plutons, and sheets during the Grenville orogeny. Rocks of the second division are predominantly of low-to-intermediate metamorphic grade, and consist mainly of sediments of the Mayo group, intruded by gabbro and granite. After the last period of Precambrian mountain-building the whole area was eroded to a peneplain. Evidence in adjacent areas indicates normal faulting during Tertiary times followed by another period of erosion and peneplanation. This faulting does not seem to have affected the Cardiff-Faraday area to any great extent. Glacial till and fluvioglacial deposits cover much of the bedrock.

The main U mines of the Bancroft area are located in these 2 townships. Deposits of apatite, corundum, feldspar, fluorite, garnet, graphite, mica, allanite, molybdenite, arsenic, dolomite, iron, marble, and talc have been found, but during 1956 and 1957, mineral production was limited to U. Occurrences of the various minerals are described.--A. C. Sangree.

2-826. Williamson, W.R.M., and P.P. Hudec. GEOLOGY OF THE WAPESI LAKE-TULLY LAKE AREA: Ontario Dept. Mines, Ann. Rept., v. 67, pt. 4, 1958, 11 p., 6 illus., 2 maps (col. geol. map in pocket, scale 1:63,360), table, pub. 1959, refs.

Geological reconnaissance of this 1,200 sq. mi. area (50°22'-50°45'N. 91°30'-92°30'W.) was carried out during the field season, 1958. Consolidated rocks are Precambrian. "They are overlain by sand, gravel, and clay of postglacial origin, and by recent swamp and bog accumulations. The Precambrian rocks can be divided into 3 main groups, granite, amphibolite, and metasediments. The granite appears to be of at least 2 ages, both being younger than the metasediments. The granites are almost entirely free of amphibole, but small bodies of amphibolite were observed forming inclusions in granite gneiss... No Keewatin-type volcanics were encountered."

The regional strike of the rocks is N. 60°-90°E. with dips generally steep, but varying locally. Original texture and structure of the metasediments have been obliterated by regional schistosity and shearing. Jointing is widespread and prominent, especially in the eastern part of the map-area. The major joints form part of a regional pattern and extend far to the N. and E. of the map-area. They control the drainage pattern and the topography. Folding is minor.

No deposits of economic significance were found. Local concentrations of magnetite in the metasediments, granite gneiss, and pegmatite are insignificant.--A. C. Sangree.

2-827. Phillips, Laurence S. PRELIMINARY REPORT ON THE PEPPLER LAKE AREA (EAST HALF), ELECTORAL DISTRICT OF SAGUENAY: Quebec, Dept. Mines, Prelim. Rept. no. 401, 12 p., fold. geol. map (Prelim. Map no. 1290), scale 1:63,360, 1959.

The area, (52°15'-52°30'N. 67°30'-67°45'W.) 180 sq. mi. in extent, is approximately 160 mi. NNW. of Sept-Iles and 20 mi. SW. of Mount Wright, in the northern part of Saguenay Electoral District. The older rocks of the area are gneiss and migmatite with concordant layers of amphibolite and granite gneiss. The overlying crystalline limestone, quartzite, schist, Fe formation, and paragneiss are probably the southwesterly extension of the Labrador Trough. These rocks are cut by gabbro, peridotite, granodiorite, and pegmatite.

The area is in the Mount Wright-Mount Reed Fe district, and it contains some excellent prospects which now are being investigated.--Quebec Dept. Mines.

2-828. Sable, Edward G. PRELIMINARY REPORT ON SEDIMENTARY AND METAMORPHIC ROCKS IN PART OF THE ROMANZOF MOUNTAINS, BROOKS RANGE, NORTHEASTERN ALASKA: U.S. Geol. Survey, Repts., Open-File Ser., [no. 498],84 p., 9 illus., 2 maps (geol. map in pocket, scale approx. 1 in. to 1 mi.), sec., table, 1959, 18 refs.

The Romanzof Mountains comprise a high, rugged mountain group in the northeastern Brooks Range. A granite body of small batholith size, the "Okpilak" granite, occupies the central part of the Romanzofs, and is flanked by sedimentary and metasedimentary rocks which range from pre-Mississippian to Jurassic in age. Mafic dikes and extrusive(?) rocks are of minor occurrence. Cretaceous(?) rocks are exposed N. of the area.

The Neruokpuk formation of pre-Mississippian age is here mapped to include several sedimentary and low grade metasedimentary rock units. These include a lower black limestone unit overlain by interbedded limestones, phyllite, argillite, slate, chert, and quartzite, in turn overlain by a thick section of quartzite and schistose quartzite. The total thickness of the Neruokpuk sequence is believed to be more than 4,400 ft. A major angular unconformity separates these rocks from the overlying Mississippian rocks.

Mississippian rocks include the Kayak "shale," a unit of light to dark gray quartzite, carbonaceous shale, and conglomerate which is O to about 400 ft. thick. The Lisburne group, of late Mississippian age, consists of gray limestone and dolomite, with minor amounts of chert, black shale, and sandstone, and is as much as 780 ft. thick. The group is overlain at least disconformably by Permian rocks.

The Sadlerochit formation, of Permian-Triassic(?) age includes a lower ferruginous sandstone member, about 200 ft. thick, consisting of Fe-stained, in part fossiliferous siltstone and sandstone interbedded with shale; a shale member, about 400 ft. thick E. of the Okpilak River, consisting of dark gray, in part pyritic shale; and a quartzite member, at least 500 ft. thick, composed of grayish and light brown, evenly bedded sandy quartzite with minor amounts of interbedded shale and thin conglomerate beds.

The Upper Triassic Shublik formation consists of a basal phosphatic sandstone overlain by black phosphatic limestone and shale. Its thickness is about 700 ft.

The Jurassic Kingak formation includes a basal siltstone member, 75 to 150 ft. thick, composed of gray, in part conglomeratic silty quartzite with thin conglomeratic lenses and beds. Above this, a shale member, consisting of black clay and silty shale with scattered ironstone nodules, is probably more than 1,000 ft. thick.

Rocks considered to be correlative with the Ignek formation of Cretaceous age crop out several miles N. of the mountain front. They include interbedded carbonaceous sandstone, siltstone and shale, and coaly beds. The thickness of the Ignek formation is unknown.

Pleistocene and Recent glacial, glaciofluvial, alluvial, and colluvial deposits are confined mostly to stream valleys within the mountains, but glacial drift covers large areas to the N.

The structure of the area consists of a "central core," the Okpilak" granite mass, around which beds in general dip outward. Overturned folds and thrust faults reflect northward tangential movement. Transverse normal and reverse faults, and transverse faults with apparent lateral movement include many which are aligned in a NNW. pattern. S.-dipping cleavage, a strong roughly N.-striking vertical joint set, and schistose rocks interpreted to lie along zones of shear are also prominent features.--Auth.

2-829. Brent, William B. PROBLEMS IN GEOLOGIC MAPPING IN WESTERN ARKANSAS: Oklahoma Acad. Sci., Proc., v. 39, 1958, p. 118-119, pub. 1959.

The area discussed is the S. flank of the Boston Mountains from 50 to 75 mi. E. of Fort Smith, Arkansas, between Ozark and Russellville, Arkansas. Peneplanation has occurred one or more times and the area is now in a mature stage of a new cycle of erosion; recent uplift is suggested. Rocks are all Pennsylvanian - Atoka, Hartshorne, McAlester, and Savanna formations. Structure is a regional dip to the S., largely masked by local folding and faulting. Folds and domes with low dips occur. Faults are normal or gravity type with relatively small stratigraphic displacement.--M. Russell.

2-830. Engel, René L. H. GEOLOGY OF THE LAKE ELSINORE QUADRANGLE, CALIFORNIA, and

**Engel, René L.H., Thomas E. Gay, Jr., and B. L. Rogers. MINERAL DEPOSITS OF LAKE ELSINORE QUADRANGLE, CALIFORNIA: California, Div. Mines, Bull. 146, 154 p. (continuously paged), 17 illus., 10 maps (5 in pocket incl. 2 col. geol. maps, scale 1:62,500), 2 profiles, 8 secs. (6 in pocket), diag. (in pocket), 6 tables, 1959, 120 refs.**

The Lake Elsinore quadrangle covers about 250 sq. mi. and includes parts of the SW. margin of the Perris block, the Elsinore trough, the southeastern end of the Santa Ana Mountains, and the Elsinore Mountains.

The oldest rocks consist of an assemblage of metamorphics of igneous effusive and sedimentary origin, probably, for the most part, of Triassic age. They are intruded by diorite and various hyabyssal rocks, then in turn by granitic rocks, which occupy over 40% of the area. Following this last igneous activity of probable Lower Cretaceous age, an extended period of sedimentation started with the deposition of the marine Upper Cretaceous Chico formation and continued during the Paleocene under alternating marine and continental conditions on the margins of the blocks. A marine regression toward the N. during the Neocene accounts for the younger Tertiary strata in the region under consideration.

Outpouring of basalts to the SE. indicates that igneous activity was resumed toward the close of the Tertiary.

The fault zone, which characterizes the Elsinore trough, marks one of the major tectonic lines of southern California. It separates the upthrown and tilted block of the Santa Ana Mountains to the S. from the Perris block to the N.

Most of the faults are normal in type and nearly parallel to the general trend of the trough, or intersect each other at an acute angle. Vertical displacements generally exceed the horizontal ones and several periods of activity are recognized. Tilting of Tertiary and older Quaternary sediments in the trough has produced broad synclinal structures which have been modified by subsequent faulting. Five old surfaces of erosion are exposed on the highlands.

The Alberhill area, in the northern part of the quadrangle, contains the largest known high-alumina clay deposits in southern California. These clay deposits have been in continuous production for the past 50 years. Other mineral resources include the metals As, Cu, Au, Pb-Ag-Zn, Mn, and Sn; and the nonmetallic commodities coal, limestone, silica, stone (including granitic dimension stone, building stone, metavolcanic road metal, and slate), and hot mineral springs.--C. H. Gray.

**2-831. Jenkins, Olaf P., ed. GEOLOGIC GUIDEBOOK ALONG HIGHWAY 49 - SIERRAN GOLD BELT-THE MOTHER LODE COUNTRY: California, Div. Mines, Bull. 141, 164 p., illus., 1948, reprinted 1959.**

The Centennial Celebration commemorating the discovery of Au at Coloma, California, in 1848 provided the impetus under which this book was created. Because of the decline in Au mining and in Au-country populations, brought about by steadily rising postwar mining costs, a gathering together of information on the mines, towns, and buildings, and mining ore was highly desirable lest this colorful page of American history be lost or irretrievably diluted. This album-shaped geologic guidebook provides a running commentary on nearly everything to be seen along or close to Highway 49, the main artery through the Au country. Rocks, minerals, mines, towns, buildings, and landscape are described, this description being interspersed with sketches of the mining and geologic history. Short chapters on the discovery of Au, general geologic setting, history of mining and milling, formation of Au lodes, and details of the buildings and culture are covered by various authorities in their respective fields.--O. E. Bowen, Jr.

**2-832. Schumacher, Genny, and others. THE MAMMOTH LAKES SIERRA; A HANDBOOK FOR ROADSIDE AND TRAIL: 145 p., illus., maps, secs., charts, diags., San Francisco, Sierra Club, 1959, refs.**

A handbook on the section lying chiefly in Mono County between Rock Creek Canyon and Lundy Canyon, where the mountains are bordered by Long Valley and Mono basin, California. The sections included are roadsides, trails, geologic story, climates and life zones, trees, wildflowers and shrubs, mammals, fish, birds, and background. The section "geologic story" explains in nontechnical terms the geologic history accounting for the principal geologic features present. A generalized monochrome geologic map, scale 1 in. to 1 mile is included. In the section on trails, information is given on where fossils or unusual rocks and minerals can be found at specific localities.--M. Russell.

**2-833. Davis, Sarah A., Elisabeth L. Egenhoff, Mary Hill, and Elinor H. Rhodes. GUIDE TO VIRGINIA CITY, NEVADA, AND THE COMSTOCK LODE AREA, WHEREIN ARE DESCRIBED POINTS OF INTEREST IN THE HISTORY OF MINING THE LODE: 55 p., 63 figs. incl. illus., col. fold. map, Sausalito, California, Pages of History, [1959], refs.**

This pamphlet briefly describes 48 points of interest in the Virginia City area including mines, buildings, mills, and physical features. Each point is numbered in the text to correspond with points upon a separate folding map in 2 colors.--J. Sinkankas.

**2-834. Gulf Coast Association of Geological Societies. FIELD TRIP GUIDEBOOK: SEDIMENTOLOGY OF SOUTH TEXAS. OCTOBER 30-NOVEMBER 1 [1958]: 114 p., 9 illus., 26 maps, 5 charts, 9 secs., 5 diags., 6 graphs, 3 logs, 9 tables, Corpus Christi, Texas, 1958, approx. 60 refs.**

This guidebook was prepared by the Corpus Christi Geological Society for the Annual Meeting of the Gulf Coast Association of Geological Societies at Corpus Christi, Oct. 27-Nov. 1, 1958.

Geologists have come to recognize the very close correlation between the present sediments of the northern Gulf of Mexico and the sedimentary tectonic history of the late Tertiary. The northern Gulf of Mexico and its adjacent low-lying Recent coastal plain, which extends for a distance of over 1,500 mi. in Texas, Louisiana, Mississippi, Alabama, and Florida, provide geologists with a very fine natural laboratory for the study of modern depositional environments, sedimentary processes, and the related sediments and faunas. The conditions which prevail in the marine environments of the continental shelf and slope and in the alluvial and deltaic environments of the coastal plain, including the numerous brackish-water lakes and bays, are similar to those which characterized much of the Tertiary period of this region. Principles of sedimentation and environmental criteria can be derived from study of the Recent geology of this region and can be applied directly to the subsurface of the same area, one of our most prolific petroleum provinces. The site of the 1958 meeting of the Association is only a few yards from the shores of Corpus Christi Bay and comparatively close to Laguna Madre, Padre Island, and the Rio Grande delta.--From. introd. & foreword.

This same trip, less some slight changes, was conducted in May 1958 by the Corpus Christi Geological Society, and a similar guidebook was published. Road logs and papers included in the guidebook are listed below.

FIELD TRIP GUIDE - ROAD LOGS
First Day - Corpus Christi to Rockport, p. 1-10.
Second Day - Corpus Christi to Brownsville, p. 11-19.
Third Day - Brownsville to Rio Hondo, p. 20-26.
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2-835. **Hall, Leo M. THE GEOLOGY OF THE ST. JOHNSBURY QUADRANGLE, VERMONT AND NEW HAMPSHIRE:** Vermont Geol. Survey, Bull. no. 13, 105 p., 41 figs. incl. 21 illus., 4 maps, 2 secs., diags., 5 pls. (in pocket) incl. 3 maps (1 col. geol. map, scale 1:62,500), secs., 7 tables, 1959, 63 refs.

Metamorphosed sedimentary and volcanic rocks of Ordovician, Silurian, and/or Devonian age underlie the St. Johnsbury quadrangle. The Ordovician rocks are part of the New Hampshire sequence and have been assigned to 2 formations, the Albee and Ammonoosuc. The Albee formation consists of 4,000 ft. of slate, quartz-mica schist, micaceous quartzite, and quartzite. The Ammonoosuc volcanics are chiefly metamorphosed soda rhyolite tuffs and flows, with some black slate and quartz-mica schist.

The Silurian and/or Devonian rocks are part of the Vermont sequence and have been assigned to 3 formations. The Waits River formation, the oldest of these, consists mainly of calcareous granulite, calcareous schist, calc-silicate rock, quartz-mica schist, and amphibolite; the apparent minimum thickness is 7,000 ft. One of the amphibolites displays well preserved pillow structure. The Standing Pond amphibolite is a member at the top of the Waits River formation. A series of micaceous quartzites, quartzites and quartz-mica schists have been mapped separately as the Crow Hill member of the Waits River formation. The Gile Mountain formation consists mainly of 5,000 ft. of interbedded quartz-mica schist, micaceous quartzite, and minor amounts of feldspathic granulite and calc-silicate rock. The Meetinghouse slate, which is made up of black slates and minor thin beds of quartzite, ranges in thickness from zero to 2,000 ft.

A comagmatic series of granitic rocks consisting of granodiorite, leucogranodiorite, quartz monzonite, and porphyritic granodiorite crop out in 8 isolated areas. The largest of these is along the western edge of the quadrangle and is the northeastern extension of a pluton that continues southwestward for 20 mi.

Two stages of deformation have been recognized in the area. The earlier stage structural features are characterized by tight isoclinal folds with an axial plane schistosity. The later stage folds which have an axial plane slip cleavage, refold the earlier folds. Of 10 major folds in the area, 5 were formed in the earlier stage of deformation and 5 in the later stage. Later minor folds far out-number the earlier minor folds. The Strafford-Willoughby arch, one of a series of domes that are present in eastern Vermont, is a later stage fold of regional extent. All other later stage folds in the St. Johnsbury quadrangle are genetically related to this arch. They show a drag sense that is opposite to what is normally expected in anticlinal structures. The formation of this arch is apparently related to the emplacement of the granitic rocks in the area. The Monroe fault is a major fault that separates the Vermont and New Hampshire sequences in the St. Johnsbury quadrangle. SE. of this fault in the New Hampshire sequence, there is no evidence of the later stage structural features.

All of the rocks in the St. Johnsbury quadrangle were metamorphosed during and slightly after their deformation. The metamorphic grade ranges from the chlorite zone through the staurolite zone to the sillimanite zone.--Auth.

2-836. Hess, H.H. CARIBBEAN RESEARCH PROJECT: PROGRESS REPORT: Geol. Soc. America, Bull., v. 71, no. 3, p. 235-240, 2 maps, March 1960, 36 refs.

Progress is reported in mapping the eastern Caribbean area; 24 Ph. D. theses have been completed or are under way. One major objective is to interpret the available geophysical data in light of the geologic history of the past 100 million years.

Mapping of a series of quadrangles from Caracas to Tinaco in Venezuela has provided a cross section through the Cordillera de la Costa and Serrania del Interior. Several episodes of mid-Cretaceous metamorphism, rather than a single episode, are now recognized.

The concept that island arcs represent an early stage of alpine-type mountain building is rejected. Alpine-type mountains are developed along the thin margin of continental crust, island arcs on an oceanic type of crust. The 2 represent different kinds of reaction to the same type of tectonic forces. Germano-type mountains develop similarly in areas of continental crust of normal thickness. All 3 types can be seen along a single tectonic axis from the Antillean islands (island arc) into the coastal ranges of Venezuela (alpine-type) and thence to the Venezuelan Andes (germano-type).

Laboratory measurements of seismic velocities in fresh peridotite (8.4 km./sec.) through partially serpentinized peridotite to serpentinite (5.7 km./sec.) indicate that the so-called basaltic crust of the oceans may be peridotite two-thirds serpentinized. If so, Mattson's basement rocks which are serpentinites may be altered mantle rocks exposed at the surface. On the other hand MacKenzie has shown that true intrusive peridotites emplaced at temperatures above a minimum of 800°C. exist.--Auth.

2-837. Mattson, Peter H. GEOLOGY OF THE MAYAGÜEZ AREA, PUERTO RICO: Geol. Soc. America, Bull., v. 71, no. 3, p. 319-361, 14 illus., 5 maps (1 fold. col.), 2 charts (1 fold.), 2 secs., diag., 3 tables, March 1960, 39 refs.

The Mayagüez area forms the southwestern corner of Puerto Rico, W. of 67°W. and S. of 18°15'N. One-third of the 640 sq. km. is covered by thick alluvium. Unconformities separate a basal complex, 2 sequences of highly folded igneous and sedimentary rocks, and a younger sequence of gently dipping sedimentary rock.

The basal Bermeja complex contains serpentinite, silicified porphyritic volcanic rock, with some sedimentary rock, and minor spilite, amphibolitized spilite, and amphibolite. It is exposed chiefly in some anticlinal cores in southwestern Puerto Rico.

Limestone, mudstone, andesite, and basalt form the older folded sequence. The Rio Loco formation, bronzite andesite porphyry in part with pillow structures, was extruded perhaps in the Cenomanian. The Mayagüez group includes most of the rocks in southwestern Puerto Rico: the Yauco mudstone, Parguera limestone, Brujo limestone, Melones limestone, Maricao basalt, Sabana Grande andesite, and El Rayo volcanic rocks. The maximum possible age range is Turonian to Maestrichtian. The group ranges in thickness from about 800 m. in the S. to 3,800 m. in the N., and it varies in lithology from limestone in the S. to mudstone and volcanic rock in the N., indicating a volcanic center to the N. during that time.

The second folded sequence contains andesitic volcanic rock, bedded tuff, and massive limestone. The San Germán formation (Maestrichtian) includes andesite, the Cabo Rojo agglomerate member, and the Cotui limestone member. The Jicara formation, massive limestone and bedded tuff, is Paleocene; there is one exposure of an unnamed Eocene(?) marl. Post-Eocene limestone and conglomerate are also exposed in the area.

The structure of the basement complex is obscured by its massiveness and by the cover of younger rocks. Two major deformations have affected the rocks of southwestern Puerto Rico since Cenomanian to Santonian time. In the Maestrichtian, the first of these formed folds with a N. 60°W. trend, asymmetric or overturned to the S. Near the S. coast the folding of thin Mayagüez group rocks was probably influenced by trends in the Bermeja complex which caused deviations in the regional trends and also some overturning to the N.

The San Germán formation, deposited unconformably on the eroded surface of the folded Mayagüez group, contains large allochthonous blocks of older and contemporaneous rocks. These blocks, up to 2 km. by 1 km. in exposure, were deposited by slumping or sliding due to gravity within and at the base and top of the San Germán formation near Lajas and San Germán. Most rocks in the blocks are extremely contorted and contain deformed Foraminifera. The San Germán and Jicara formations and perhaps the Eocene(?) marls were deformed into gentle open folds trending E. in the area covered by this report. Oligocene, Miocene, and younger sedimentary rocks have been tilted and uplifted.

Large E.-W. left-lateral transcurrent faults cross the area, offsetting and offset by 2 sets of transverse faults (N. 45°E., N. 20°W.): most faults are probably Maestrichtian to Oligocene, although minor faulting has continued to the present.

Dikes and sills of quartz diorite porphyry and mica-quartz dacite porphyry intrude the Maestrichtian(?) San Germán formation and older units. A diorite plug cuts the Bermeja complex, and a granodiorite plug intrudes the Mayagüez group.--Auth.

2-838. MacLachlan, James C., Reginald Shagam, and H.H. Hess. GEOLOGY OF THE LA VICTORIA AREA, ARAGUA, VENEZUELA: Geol. Soc. America, Bull., v. 71, no. 3, p. 241-247, 2 maps (1 fold. col.), 2 secs., table, March 1960, 4 refs.

MacLachlan mapped the La Victoria area in the period 1949 to 1951, accepting R.J. Smith's stratigraphic subdivisions. Shagam later demonstrated that the Paracotos formation of Smith contained within it a major unconformity and consigned the lower part of it to a new formation, the Tucutunemo, reserving the designation Paracotos formation for the upper portion characteristic of the type locality near the town of Paracotos.

The Tucutunemo formation lies conformably above the Las Mercedes formation of the Caracas group and hence is assigned as the uppermost formation in that group. Within this formation the Los Naranjos member, consisting in large part of flow breccias and tuffs, represents the beginning of volcanic activity accompanying the earliest stages of mountain building. The Villa de Cura group, consisting largely of volcanic rocks, is thought to lie above the Caracas group, but no contact between the 2 has been found. They are separated by a fault trough containing younger (Maestrichtian) Paracotos formation rocks.

The Tiara formation lavas postdate the main episode of metamorphism which has affected the Caracas and Villa de Cura groups but predate the Paracotos formation which contains Tiara pebbles.

Paleocene rocks lie unconformably upon the folded and slightly metamorphosed Paracotos formation.

Hornblende-quartz diorite and sodic granite intrude Caracas group rocks and are metamorphosed with them. Serpentinized peridotites occur along the Paracotos fault trough and are at least in part emplaced as solid intrusions. Gabbro intrusions also are found along this trough.

The structure is complicated in detail but comparatively simple in broad aspect.--Auth.

2-839. Shagam, Reginald. **GEOLOGY OF CENTRAL ARAGUA, VENEZUELA:** Geol. Soc. America, Bull., v. 71, no. 3, p. 249-302, 12 illus., 3 maps (2 fold. incl. col. geol. map, scale 1:50,000), 3 charts, 2 secs., 2 diags., 3 tables, March 1960, 47 refs.

The central Aragua area is on the southern flank of the mountain ranges of N.-central Venezuela. The S. boundary of the map-area separates the mountainous-metamorphic zone from the low hills and plains underlain by unmetamorphosed rocks to the S.

Most of the area is underlain by a sequence of metamorphosed volcanic rocks more than 3,000 m. thick, the Villa de Cura group. This sequence has been subdivided into 4 conformable formations. The lowest 3 formations (El Cano, El Chino, and El Carmen) consist of metamorphosed spilitic basalts and associated volcanic sedimentary rocks. These rocks are now greenstones, some of which contain glaucophane. A striking feature of the metalavas is the presence of unaltered augite. The uppermost (Santa Isabel) formation is considerably more siliceous than the lowest 3 formations and consists of chlorite-quartz-albite schists and granulites; many rocks contain glaucophane. The Santa Isabel rocks closely approximate keratophyre lavas in chemical composition but are clearly of sedimentary origin. Dioritic rocks intruded into the Santa Isabel formation predate the main metamorphism.

N. of the Villa de Cura group a sequence of carbonaceous phyllitic schists and metamorphosed lithic arenite sandstones and conglomerates and a distinctive limestone with large clastic calcite grains crop out. The sequence, the Tucutunemo formation, is considered to be the uppermost member of the Caracas group of metasedimentary rocks and to overlie conformably the Las Mercedes formation.

The volcanic rocks of the Villa de Cura group are considered to have been erupted after the deposition of the Tucutunemo formation. Possibly the volcanic rocks were erupted in a geographically separate area. Scanty paleontologic evidence suggests an Early Cretaceous age for the Caracas group.

In mid-Cretaceous times the main crustal deformation took place, accompanied by the intrusion of ultramafic rocks. The grade of metamorphism attained was not greater than that represented by the albite-epidote-amphibolite facies of regional metamorphism.

After the deformation another series of spilitic basalts and tuffs, the Tiara volcanic rocks, was extruded. These extrusions are texturally and mineralogically distinct from those of the Villa de Cura group. The Arrayanes formation on the southern boundary of the map-area consists of lithic wacke siltstones, sandstones, and conglomerates composed largely of Tiara pebbles. The formation is dated by a Coniacian ammonite found near San Juan de los Morros. Neither the top nor the bottom of the formation have been observed.

In Maestrichtian to Paleocene times deposition of calcareous lithic wacke siltstones and sandstones and aphanitic foraminiferal limestones was continuous. The Maestrichtian sequence in the present mountain belt is referred to as the Paracotos formation. A second weaker orogeny began after the deposition of the Paracotos formation. The Tiara and Paracotos formations were caught within the deforming mountain belt and underwent mild dynamic metamorphism. The Arrayanes and Maestrichtian rocks to the S. were merely carried northward on the S. limb of this belt and were unaffected by the metamorphism. During Paleocene time, deposition was conformable with the Maestrichtian in the S. but unconformable in the N. A third weak deformation took place in late- or post-Paleocene time.

The dominant structural trend of N. 75°E. is explained by NNW.-SSE. compression. This compression could have resulted from a E.-W. shear couple produced by the movement of the Caribbean block eastward into the deforming arcuate tectogene. Normal faulting, possibly in response to isostatic adjustment, took place after the deformations. This faulting was accompanied by solid reinjection of the ultramafic rocks.--Auth.

2-840. Thorarinsson, S., and T. Tryggvason. GEOLOGY IN ICELAND: GeoTimes, v. 4, no. 6, p. 8-10, 3 illus., March 1960.

The geology of Iceland is dominated by Tertiary and Quaternary volcanism. Iceland lies in the Thulean basaltic province; in some parts volcanic activity is still going on. Two stratigraphic basalt series are recognized: the Regional and the Insular. Geothermal energy is manifested in many forms, including geysers and hot springs, and is used as a source of heat in Reykjavík. There are few geologists in Iceland, although the geologic problems are many and varied.--M. Russell.

# 2. GEOMORPHOLOGY

See also: Paleontology 2-880, 2-884; Sedimentary Petrology 2-935; Geohydrology 2-943; Engineering Geology 2-1013, 2-1017.

2-841. Langleben, M.P. **SOME PHYSICAL PROPERTIES OF SEA ICE. II: Can. Jour. Physics, v. 37, no. 12, p. 1438-1454, 7 illus., 4 profiles, 4 diags., 3 graphs, 2 tables, Dec. 1959, 9 refs.**

Some properties of annual sea ice at mid-temperate latitudes are investigated. It is found that the salinity is comparable to, and the density much lower than, annual arctic sea ice. Permeability to air flow compares favorably to calculations based on the model of sea ice of Anderson and Weeks. Small sample ring tests of ultimate tensile strength yield values ranging from 9.5 to 24.8 kg. $cm.^{-2}$ at test temperatures of -3.6°C. to -17.2°C. Tensile strength appears to depend on crystal size rather than on brine content.--Auth.

The first part of this article was listed as GeoScience Abstracts 1-2716.

2-842. Loewe, Fritz. **EXPLORATION OF "INLAND ICE," GREENLAND AND ANTARCTICA. Translated from Die Erforschung der "Inlandeise" Grönland; Antarktis, Umschau, 1956, Heft 4, p. 110-113, by Katherine Martinoff: U.S. Snow, Ice & Permafrost Research Establishment, Translation 58, 5 p., 7 illus., map, May 1959, 13 refs.**

The Greenland ice cap covers 12 million sq. km.; most of Antarctica is covered by unbroken ice cover. The mean elevation of the Greenland ice cap is 2,100 m.; Antarctica's ice cap is approximately the same elevation. The mean ice thickness is 1,500 m.; the maximum is greater than 3,000 m. During a hurricane, at least 250,000 tons of snow passed over a 1-km. front in 1 day.--M. Russell.

2-843. Frye, John C., Paul R. Shaffer, H.B. Willman, and George E. Ekblaw. ACCRETION-GLEY AND THE GUMBOTIL DILEMMA: Am. Jour. Sci., v. 258, no. 3, p. 185-190, March 1960, 9 refs.

Inclusion of materials of different origins under the terms "gley" and "gumbotil" has let to misinterpretations and to confusion. It is suggested that in Pleistocene geology the term "gley" be used only for the gleyed material in a developed soil profile, and the term "accretion-gley" be used to designate deposited materials. It is further suggested that the term "gumbotil" be restricted in application to materials developed in situ. If such a restriction is not generally accepted, the term "gumbotil" should be abandoned.--Auth.

2-844. Frye, John C., and H.B. Willman. CLASSIFICATION OF THE WISCONSINAN STAGE IN THE LAKE MICHIGAN GLACIAL LOBE: Illinois State Geol. Survey, Circ. 285, 16 p., chart, 1960, 43 refs.

The revised time-stratigraphic classification of the Wisconsinan stage of the Lake Michigan lobe as used by the Illinois State Geological Survey consists of the following substages in descending order: Valderan, Twocreekan, Woodfordian, Farmdalian, and Altonian. Extrapolation from presently available radiocarbon dates suggests that Wisconsinan time started 50,000 to 70,000 radiocarbon years ago and terminated approximately 5,000 radiocarbon years ago. More than half of this time falls within the Altonian, the oldest of the substages. New rock-stratigraphic names introduced are Roxana silt, Morton loess, and Richland loess. A new category of units based on surface form of the deposits is introduced as morphostratigraphic classification.--Auth.

2-845. **MacClintock, Paul, and Jaan Terasmae. GLACIAL HISTORY OF COVEY HILL: Jour. Geology, v. 68, no. 2, p. 232-241, 7 figs. incl. 2 maps, profile, diags., March 1960, 17 refs.**

The abandoned spillway across Covey Hill has long been accepted as one of the overflow channels of the Great Lakes, occupied when "the ice sheet" had receded to a position N. of the Adirondacks but still blocked the St. Lawrence drainage below this level, now a thousand feet above present sea level.

Current investigation reveals that the area has been glaciated by 2 Wisconsin ice invasions. The first one came from the NE. and overrode the whole area, whereas the second one came as a readvance from the NW. and only impinged against the N. flank of Covey Hill where it built a terminal moraine. It was this latter ice that dammed the St. Lawrence and caused its drainage to overflow at Covey Hill. Radiocarbon dates on peat and on Champlain Sea shells, which overlie this latter till, show it to be pre-Two Creeks, i.e., Port Huron in age. Covey Hill gap is therefore also dated as Port Huron (Mankato) in age. Along the N. slope of Covey Hill is a well-developed marine shore line at 525 ft. above present sea level, whereas in the lowlands to the N. the base of the marine Champlain clays is now at 200 ft. above present sea level. These clays lie here on varved lake clays, the top of which show mud cracks, dessication breccia, oxidation, and fluvial erosion, and they demonstrate an episode of dry land which was later flooded by eustatic rise of sea level to make the Champlain Sea. These relations demonstrate that sea level had been lowered at least 325 ft. during this part of the Pleistocene.--Auth.

2-846. Thorén, Ragnar. FROST PROBLEMS AND PHOTO INTERPRETATION OF PATTERNED GROUND: Photogramm. Eng., v. 25, no. 5, p. 779-786, 14 illus., Dec. 1959, 23 refs.; abs. in English & German.

Frost conditions of both the seasonal and permanent type are of considerable importance in agriculture, road buildings, and building construction in arctic areas. Photographic interpretation offers great possibilities in the analysis of frost conditions. This is because the various types of frost conditions may be identified by a number of tone and texture patterns which they create on the ground, and which are readily visible in aerial photography.--Auth.

2-847. Kaatz, Martin R. PATTERNED GROUND IN CENTRAL WASHINGTON: A PRELIMINARY REPORT: Northwest Sci., v. 33, no. 4, p. 145-156, 4 illus., 2 maps, Nov. 1959, 23 refs.

The origin of patterned ground which covers hundreds of square miles on Manastash Ridge and portions of adjacent Kittitas Valley and Yakima County in central Washington state is reviewed. It is demonstrated that intensive frost action during a periglacial climate is the prime factor of development.--M. Russell.

2-848. Schumm, S.A. THE EFFECT OF SEDIMENT TYPE ON THE SHAPE AND STRATIFICATION

OF SOME MODERN FLUVIAL DEPOSITS: Am. Jour. Sci., v. 258, no. 3, p. 177-184, 4 illus., 4 secs., graph, March 1960, 9 refs.

The percent silt-clay in sediment appears to be ndicative of some physical properties of that sediment. Silt-clay is defined as that material passing he 200 mesh sieve or smaller than 0.074 mm. The shape of a stream channel cross section is found to be inversely related to the weighted mean percent silt-clay in channel banks and floor. The shape of paleochannels and their included channel-fill deposits may be similarly related to sediment type.

Observations along actively aggrading streams suggest that the stratification of channel-fill deposits may also be related to the percent silt-clay in these deposits. Stratification planes may be concave in channel fills composed of predominant silt-clay, whereas, they may be horizontal where the silt-clay content of the alluvium is small, and even convex in hose channel fills with negligible silt-clay.--Auth.

2-849. Braden, Gladys E. FLOW AROUND BENDS IN STREAM CHANNELS: Oklahoma Acad. Sci., Proc., v. 39, 1958, p. 115-117, pub. 1959, 11 refs.

A review of the history of research on this subject s given. The theory of helicoidal flow is supported by tests on the Iowa River but discredited by observed phenomena along the Mississippi River. Tests conducted on a model stream constructed in unconsolidated sediments on a mountain slope near Lander, Wyoming show the development of typical meanders.--M. Russell.

2-850. Daniels, Raymond B. ENTRENCHMENT OF THE WILLOW DRAINAGE DITCH, HARRISON COUNTY, IOWA: Am. Jour. Sci., v. 258, no. 3, p. 161-176, 4 illus., map, 3 profiles, March 1960, 3 refs.

The changes in the Willow drainage ditch since 1919-1920 have been reconstructed by comparison of he original profile of the ditch, historical records, and a survey of the ditch in 1958. Since construction, he drainage ditch has filled where the ditch was constructed on the Missouri River valley. The drainage ditch in the Willow River valley has entrenched, however, and becomes progressively deeper upstream, attaining a maximum depth of 42 ft. at the Monona-Harrison County line.

The drainage ditch in the Willow River valley apparently deepened by channel scour and headward movement of knickpoints, but in a number of enrenchments rather than a single entrenchment folowed by stabilization. Once a knickpoint has passed a point in the drainage ditch, stabilization of the channel does not necessarily follow, but channel scour may deepen the ditch more than passage of the knickpoint.

The filling of the lower part of the drainage ditch robably is caused by the sharp decrease in gradient f the ditch, and by coinciding periods of high water n the Boyer drainage ditch or the Missouri River, o which the Willow is affluent. The entrenchment n the Willow River valley probably was produced y a constructed increase in gradient of the drainage itch as contrasted to that of the original river gradient in the same area.

The entrenchment of the Willow drainage ditch has een responsible for much of, but cannot explain all f, the entrenchment of its tributary streams.--Auth.

2-851. Harper, Horace J., and Lester W. Reed. A FIFTH REPORT ON THE ACCUMULATION OF RECENT ALLUVIUM IN DEEP FORK OF THE NORTH CANADIAN RIVER VALLEY IN LINCOLN COUNTY, OKLAHOMA: Oklahoma Acad. Sci., Proc., v. 39, 1958, p. 126-130, map, 2 tables, pub. 1959, 4 refs.

A further report on the progressive silting of Deep Fork valley resulting from the completion of a drainage ditch in 1923. The silted area has extended upstream 1.5 mi. in the years 1954-1958, for a total of 18.6 mi. since the completion of the drainage ditch. Burning of log jams and application of 2, 4, 5-T to kill willows and cottonwoods would help to lower the Deep Fork channel to original level; this would reduce flood hazards and increase the agricultural potential of the valley.--M. Russell.

2-852. National Speleological Society, Washington Speleological Survey. INITIAL BIBLIOGRAPHY OF WASHINGTON SPELEOLOGY: Its: Bull. 1, 8 p., Dec. 1959.

Contains 103 references to caves of Washington and related speleological subjects, listed alphabetically by author. Periodic supplements are planned.

2-853. Takahasi, Eitaro, and Michihiro Kawano. SPELEOLOGY IN JAPAN. Introduction by William R. Halliday: Natl. Speleol. Soc., Bull., v. 21, p. 45-54, 5 illus., 4 maps, July 1959, 9 refs.

Speleology in Japan is a relatively young undertaking. Post-war studies of cave and karst are centralized in the Japanese Association for Scientific Research of Caves and Underground Water and in the Japanese Association for Quaternary Research. Limestone is not extensive in Japan and occurs in several, small, isolated regions. Limestone caves and karst features are well developed. Typical of such development is the Akiyoshi plateau, a limestone karst region 15 km. long, 7 km. wide, at the S. end of Honshu. Five caves, over 1,000 ft. long, are in the area along with 19 smaller ones. Karrenfelder, dolines, and pits are well developed on the plateau.--Auth.

2-854. Geyl, W.F. GEOPHYSICAL SPECULATIONS ON THE ORIGIN OF STEPPED EROSION SURFACES: Jour. Geology, v. 68, no. 2, p. 154-176, 12 diags., profile, table, March 1960, 31 refs.

Stepped erosion surfaces are a widespread feature in Australia (as in other parts of the world) and suggest a phased lowering of relative sea level without deformation of the land during the later Cenozoic.

An hypothesis is put forward that the stepped erosion surfaces are ultimately caused by continental "shift" induced by deep convection currents. New ocean capacity is created in the "oceanogenic" zone, while a smaller ocean capacity is lost in the orogenic zone, leading to a eustatic drop of sea level. This causes rejuvenation of erosion in the nonorogenic land masses, which tend to rise isostatically. But as the young folded mountains also rise isostatically as compression ceases, they suffer extreme erosion, and the consequent sedimentation in the oceans leads to a eustatic rise of sea level. The isostatic adjustment of the loaded ocean floor and unloaded land, assumed to act with appreciable time lag, leads to a long-continued drop of relative sea level, eustatic insofar as sea level drops with the sinking ocean floor, epeirogenic insofar as the land rises. In older and higher erosion surfaces the epeirogenic component predominates. In lower and younger erosion surfaces the eustatic component may be more significant, but it can never account for more than about 800 ft. of their elevation above present sea level. The adjustment is spasmodic, but other factors may also operate to give the periods of stability of relative sea level which lead to the initiation of erosion surfaces. An erosion surface will continue to work upstream long after it has been once or several times removed from direct control by sea level/base level, and it will indeed do so today if still recognizable, even though it may have been initiated millions of years ago; we must be aware of this "age duplicity."

The work particularly of Baulig and Du Toit must be thought to have foreshadowed the present hypothesis.

Quantitative estimations of the effects of "shift" on relative sea level show results in reasonable agreement with the elevations of actual erosion surfaces, and so give support to the hypothesis.--Auth.

2-855. Inman, Douglas L., and Jean Filloux. BEACH CYCLES RELATED TO TIDE AND LOCAL WIND WAVE REGIME: Jour. Geology, v. 68, no. 2, p. 225-231, illus., map, 2 profiles, table, March 1960, 2 refs.

Along portions of the northwestern coast of the Gulf of California the beaches exhibit a fortnightly cycle of erosion and deposition which is related to the combined effects of the tides and the waves generated by the daily "sea breeze." In this area the higher waters of spring tide occur during the early afternoon when the "sea-breeze" regime is strongest. This coincidence of maximum wave intensity during the times of highest water causes the position of the beach berm to follow the elevation of the envelope of the higher high waters in a fortnightly cycle.

A record of the beach cycle is preserved within the beach face by the bands of heavy minerals that are concentrated by wave action at the level of each high water.--Auth.

2-856. Wahrhaftig, Clyde. THE PHYSIOGRAPHI PROVINCES OF ALASKA: 76 p., 6 pls. [not seen], U.S. Geological Survey, Jan. 1960, 3 refs.

Twelve provinces are delimited and these in turn are divided into 60 sections on the basis of physiographic characteristics. The provinces described are: 1) Arctic Coastal Plain, a smooth plain rising from the Arctic Ocean to an altitude of 600 ft., divide into 2 sections; 2) Arctic Foothills, rolling plateaus and low linear mountains; 3) Arctic Mountains, mountains and hills in folded and overthrust Paleozoic and Mesozoic sedimentary rocks, 4 sections; 4) Northern Plateaus, uplands and lowlands in Paleozoic and Precambrian rocks, 10 sections; 5) Western Alaska, uplands and lowlands in folded and faulted Cretaceou rocks, 16 sections; 6)-8) Provinces in and bordering the Bering Sea, 4 sections; 9) Alaska-Aleutian Province, an arcuate belt of mountain ranges along the N. side of the Pacific Mountain system in Alaska, 5 sections; 10) Coastal Trough, a belt of lowlands extending the length of the Pacific Mountain system, interrupted by oval mountain groups, 11 sections; 11) Pacific Border Range, several mountain ranges bordering the Pacific Coast, 6 sections; 12) Coastal Mountains, a massive barrier underlain by the Coas Range batholith, 2 sections.--M. Russell.

## 3. STRUCTURAL GEOLOGY

See also: Mineral Deposits 2-975; Fuels 2-1001, 2-1003.

2-857. Satin, Lowell R. APPARENT-DIP COMPUTER: Geol. Soc. America, Bull., v. 71, no. 2, p. 231-233, 2 diags., Feb. 1960, 4 refs.

Three methods for correcting dip not perpendicular to strike are generally used: 1) dip correction tables, 2) alignment diagrams, and 3) the dip correction protractor. A circular apparent-dip computer which has several advantages over earlier methods is described. A single setting computes the value of any apparent dip for a given true dip, and vice versa. The computer is also useful as a drafting aid.--B. W. Pipkin.

2-858. Haites, T. Binnert. TRANSCURRENT FAULTS IN WESTERN CANADA: Alberta Soc. Petroleum Geologists, Jour., v. 8, no. 2, p. 33-78, 2 illus., 4 maps, chart, 3 diags., table, Feb. 1960, 144 refs.

Transcurrent faults occur in the Canadian Shield as well as in the Interior Plains and the Cordillera. They play a major role in the fabric of the western Canadian region. Their preferential azimuths fit in a world-wide regmatic shear pattern. A Precambrian initiation of this fault system has been postulated.

Recognition of transcurrent faults has lagged far behind that of dip-slip faults due to the paucity of reliable markers. Markers particularly suited to detect such movement in the plains of western Canada can be used to delineate the Drumheller fault and other transcurrent faults.

The absence of a hanging wall in vertical transcurrent faulting facilitates gaping. Accordingly, ascending magmas and juvenile waters, migrating hydrocarbons and connate waters, as well as circulati meteoric waters should show a preference for these faults.

The association of earthquakes with transcurrent faults is strongly suggested. Linear disintegration ridges represent cracks in the continental ice-sheet that were enlarged by meltwater and filled with englacial and subglacial material. The cracks sugges fault activity during the late Pleistocene. Fault control is also proposed for some linear meltwater channels and the present rectangular drainage syste in western Canada.--Auth.

2-859. Balk, Robert. STRUCTURAL BEHAVIOR OF IGNEOUS ROCKS (With Special Reference to Interpretations by H. Cloos and collaborators): Geo Soc. America, Mem. 5, 177 p., 38 figs. incl. illus maps, secs., diags., July 1937, reprinted 1959, 7 refs.

2-860. Scheidegger, Adrian E. THE OROGENETIC SIGNIFICANCE OF A SOFT LAYER AT 140 K DEPTH: Jour. Geology, v. 68, no. 2, p. 177-181, March 1960, 8 refs.

Gutenberg has shown that certain features in the ravel time curves of seismic phases can be explained s the result of the presence of a velocity minimum or the wave propagation at a certain depth. He also dvanced the hypothesis that this low-velocity zone s a "decoupling" zone between the material above it nd that below it. Because this low-velocity zone lso represents the wave guide for the G-waves, and he latter reaches around the whole globe, the deoupling zone would have to be present everywhere. )riginally the decoupling zone was assumed to be at ome 70 km. depth, but it now appears that it has to e put at 140 km. The present paper investigates the ffect of the presence of such a decoupling zone at he specified depth upon the various theories of oroenesis. It is shown that all those theories of mounain-building which are based upon the assumption hat crustal shortening is the cause of mountains, are ffected to the extent that the shortening required is ow much less than previously estimated. The other heories of mountain-building are only superficially ffected.--Auth.

2-861. Sutton, Robert G. STRUCTURAL GEOLOGY OF THE DRYDEN AND HARFORD QUADRANGLES, NEW YORK: 15 p., map, diag., table, Albany, New York State Museum and Science Service, July 1959, 9 refs.

The regional dip of upper Devonian strata in the Dryden and Harford (15-min.) quadrangles of S.-central New York is S. 20°W. at 40 ft. per mi. Small domes and a fault(?) form a pattern similar to that which occurs in W.-central New York. No evidence could be found of the anticlinal structures previously reported for the area.

The structures were determined by reconnaissance geologic mapping of 3 zones: 2 black shales in the lower Enfield, and the base of the Cayuta formation, as defined by Cyrtospirifer chemungensis. Subsurface data, although meager, appear to reflect these structures in the Tully limestone. The drainage pattern also shows some structural control.

The possibility that the structural pattern exists in adjacent areas is discussed.--Auth.

## 4. STRATIGRAPHY AND HISTORICAL GEOLOGY

ee also: Areal and Regional Geology 2-828; Geomorhology 2-844; Paleontology 2-879, 2-888, 2-892; edimentary Petrology 2-937, 2-942.

-862. Dunbar, Carl O. HISTORICAL GEOLOGY: d ed., 500 p., 406 figs. incl. illus., maps, charts, ecs., diags., tables, New York, John Wiley & Sons, 960, refs.

This volume is a successor to, and an outgrowth f, the Textbook of Historical Geology by Schuchert nd Dunbar. It preserves the same point of view and he same general organization except for the introluctory chapters which are arranged so as to bring he geologic time scale near the front. The text of he previous work has been largely recast to take ccount of advances in knowledge or to make a more ffective presentation. Special care has been given o the illustrations, many of which are new.

Believing it to be more important for the student o learn how a geologist thinks about the Earth than hat he thinks about any particular detail, the author as taken pains to emphasize principles of interpretion rather than to catalogue facts about the history f the Earth, appealing thus to understanding rather han to memory.--From auth. pref. to 1st ed.

In attempting to bring the subject up to date, the uthor has maintained the general organization of e first edition, but several of the chapters have een completely rewritten and most of the text has een recast in order to include new information and make a more effective presentation. Discussion the cosmic history of the earth has been shifted to e Prologue as chap. 4, preceding the chapter on volution, which is introduced by a brief epitome of urrent speculation on the origin of life on earth.--rom auth. pref. to 2d ed.

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Appendix A. An Introduction to Animals and Plants

2-863. Parker, Mary C., Fred H. Dorheim, and Russell B. Campbell. RESOLVING DISCREPANCIES BETWEEN SURFACE AND SUBSURFACE STUDIES OF THE MAQUOKETA FORMATION OF NORTHEAST IOWA: Iowa Acad. Sci., Proc., v. 66, p. 248-256, map, sec., 1959, 9 refs.

The Maquoketa formation [Ordovician] in the outcrop area has been assigned a maximum thickness of 257 ft. by earlier surface workers. Recent subsurface study in the same area reveals a thickness of 300-320 ft. of Maquoketa sediments. Until now the correlation of subsurface units to recognized surface members has been hampered by this discrepancy.

The recognition and identification of a new unit in the Elgin member of the Maquoketa formation, and a greater measured thickness of the Isotelus zone has resolved this difference.--Auth.

2-864. Winterer, Edward L., and Michael A. Murphy. SILURIAN REEF COMPLEX AND ASSOCIATED FACIES, CENTRAL NEVADA: Jour. Geology, v. 68, no. 2, p. 117-139, 7 pls., 4 maps, 2 secs., March 1960, 24 refs.

The Silurian system of the Great Basin comprises at least 3 major facies: 1) a dolomite facies, developed in Utah and in eastern and central Nevada (Laketown dolomite and Lone Mountain dolomite), 2) a limestone facies, locally dolomitized, exposed in central Nevada (Roberts Mountains formation), and 3) a chert-shale facies, probably deposited originally in central and western Nevada, but since carried eastward into central Nevada by large-scale thrust faulting.

Mapping in the Roberts Mountains region in central Nevada shows that the Lone Mountain dolomite and the Roberts Mountains formation are largely, and perhaps wholly, lateral equivalents. Evidence from textures, structures, and fossils indicates that the Lone Mountain dolomite represents a reef complex, most of whose original features are obliterated by dolomitization, and that the Roberts Mountains formation comprises deeper-water reef-flank, off-reef, and basin deposits. A regional isopach map shows a generally N.-trending band through the Roberts Mountains in which the Silurian is as much as 4 times as thick as the regional average for the system - that is, 4,500 versus 1,000 ft. The reef complex of the Lone Mountain dolomite merges with the thinner but lithologically similar Laketown dolomite to the E. but interfingers abruptly with the lithologically dissimilar Roberts Mountains formation, which thins very rapidly westward.--Auth.

2-865. Baxter, James W. **SALEM LIMESTONE IN SOUTHWESTERN ILLINOIS**: Illinois State Geol. Survey, Circ. 284, 32 p., 16 illus., 4 maps, sec. (in pocket), diag., 3 tables, 1960, 20 refs.

The Salem limestone [Mississippian], which crops out in and adjacent to the Mississippi River bluffs in southwestern Illinois, is here subdivided into the Kidd, Fults, Chalfin, and Rocher members in Monroe, Randolph, and St. Clair counties.

The Kidd and Rocher members (and less commonly the Chalfin member) at places contain high-Ca limestone. The best areas for the thicker deposits of high-Ca limestone are in the vicinity of Prairie du Rocher, Fults, and Kidd. Thirty-one chemical analyses and data on the insoluble residue of several hundred samples give specific information on composition for 9 selected locations.

The Kidd member, which is 50 to 90 ft. thick, is primarily a biocalcarenite composed largely of crinoid fragments and bryozoan debris.

The Fults member, which is about 30 ft. thick, consists of alternating fine-grained dolomitic limestone and calcarenite. The base is marked by laminated, very silty, argillaceous limestone which, except locally, is dolomitic. Banded and nodular chert are prominent.

The lithology of the Chalfin member varies. Part of the member is fine-grained limestone. Dense microcrystalline limestone occurs at the top and bottom, and the upper portion has prominent beds composed of nonskeletal pellets the size of silt and fine sand. Local features include breccia, channel cut-and-fill deposits, plant fossils, and possibly algal limestone.

The Rocher member consists predominantly of calcarenitic limestone composed largely of Endothyra and is commonly more or less oolitic. Its thickness ranges from 10 to more than 60 ft. in bluff exposures and locally increases in wells drilled E. of the bluff.

The environment of Salem deposition possibly was similar to that now existing on the Great Bahama Banks.--Auth.

2-866. McDuffie, R.H. **LITHOLOGIC BASIS FOR CORRELATION OF MISSISSIPPIAN ROCKS IN THE SUBSURFACE BETWEEN KANSAS AND NORTH CENTRAL OKLAHOMA**: Oklahoma Acad. Sci., Proc., v. 39, 1958, p. 133-135, pub. 1959, 3 refs.

By comparison of lithology, the Chesterian, Meramecian, and Osagean units of the Mississippian system as subdivided in Kansas, can be correlated into N.-central Oklahoma and their approximate subsurface limits defined. Due to contradicting lithologic correlations and the lack of sufficient evidence to support a definite age assignment, the lowermost beds of the Mississippian system in N.-central Oklahoma are considered as either Kinderhookian or Osagean in age.

The Osagean unit as described by Clair is identifiable in N.-central Oklahoma and constitutes the greater part of the Mississippian system throughout the area. The Meramecian unit is relatively thin where present and is distinguished from the underlying Osagean unit by its lighter color, coarser texture, and lesser amount of chert. The Chesterian unit present only in the SW. part of the area (SW. Garfield County) is readily distinguished from the underlying Meramecian sediments. However, it is difficult to determine the boundary between the Chesterian and overlying Pennsylvanian shales.--L. Jordan.

2-867. Champlin, Stephen C. **THE PROBLEM OF THE WELDEN, SYCAMORE AND LOWER CANEY IN THE EASTERN ARBUCKLE MOUNTAINS**: Oklahoma Acad. Sci., Proc., v. 39, 1958, p. 120-124, sec., pub. 1959, 12 refs.

A time-rock correlation is attempted between the Mississippian sections on the northern and southern flanks of the Arbuckle Mountains, Oklahoma. One handicap is that the zone of facies change has been removed by erosion over the Arbuckle Mountains. Another is that little is known of the nature of the Tishomingo ridge complex. This ancient structural feature probably contributed some sediments to the early Mississippian seas, but to what extent it controlled deposition of early and middle Mississippian sediments is not known. Another major handicap is the lack of a representative faunal assemblage in the "pre-Sycamore" unit. The Welden formation is recognized on the S. flank of the Arbuckle Mountains; this formation is present throughout much of southern Oklahoma and maintains remarkably uniform lithologic characteristics throughout the area.--M. Russell.

2-868. Tappan, Helen. **CRETACEOUS BIOSTRATIGRAPHY OF NORTHERN ALASKA**: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 3, pt. 1, p. 273-297, 2 maps, 2 pls., 4 charts, sec., March 1960, 51 refs.

The lithologic and microfaunal facies of the Cretaceous sediments of the Arctic Slope of northern Alaska are discussed and their depositional environments suggested. The faunas differ from usual Cretaceous assemblages in being controlled by high turbidity and turbulence and rapid deposition, as well as rapid fluctuations of sea level, with resultant intertonguing marine and nonmarine strata. Nonmarine strata (fluviatile environment) and the coastal deposits (supralittoral) contain charophyte oögonia, but no Foraminifera; the intertidal coastal deposits contain environmentally tolerant arenaceous species, which are represented by stunted specimens with little variety, but are locally present in large numbers. The nearshore deposits of turbidity-controlled facies contain large robust specimens of arenaceous Foraminifera, in general of the same cosmopolitan species as those of the intertidal region. A few calcareous Foraminifera and some Radiolaria are also present, but occur as pyritic casts, a further indication of their rapid burial. The more usual offshore faunas are less characteristic of Alaska, occurring in the subsurface of the present coastal region; there the arenaceous and calcareous species occur in nearly equal variety, and the calcareous Foraminifera and the Radiolaria occur as shells rather than as casts. Strong currents from land seem to have prevented the influx of planktonic Foraminifera, except for a single zone in the Seabee formation, of Turonian age, which locally contains *Heterohelix* and *Hedbergella*.

Microfaunal zones based on the arenaceous species are discussed, each being approximately equivalent to one of the European stages. The *Gaudryina tailleuri* zone is of lower Albian age, the *Verneuilinoides borealis* zone represents the middle and upper Albian, the *Gaudryina irenensis*-*Trochammina rutherfordi* zone is Cenomanian, the *Pseudoclavulina hastata*-*Arenobulimina torula* zone is Turonian and the *Trochammina ribstonensis*-Neobulimina canadensis zone is Senonian. On the basis of these zones and the other species of Foraminifera contained therein, correlations are made with Cretaceous strata in Canada and the United States. Descriptions and illustrations of a few previously undescribed species are also presented.--Auth.

2-869. Curtis, Nevelle M., Jr. NOMENCLATURE OF THE WASHITA GROUP (CRETACEOUS) IN THE RED RIVER AREA, OKLAHOMA AND TEXAS: Oklahoma Geology Notes, v. 19, no. 12, p. 257-264, illus., map, sec., chart, Dec. 1959, 14 refs.

Historical development of the Washita group nomenclature in the Red River area. Photograph and history of Fort Washita, Bryan County, Oklahoma, and map showing route of Marcy's expedition, 1849-1852, across southeastern Oklahoma. This route crossed the type locality for the Washita group. Includes measured section by R. T. Hill of the beds of the Washita group between Duck Creek and Denison, Texas. --Auth.

2-870. DeFord, Ronald K., and Luther W. Bridges. TARANTULA GRAVEL, NORTHERN RIM ROCK COUNTRY, TRANS-PECOS, TEXAS: Texas Jour. Sci., v. 11, no. 3, p. 286-295, 2 maps, Sept. 1959, 11 refs.

Volcanism that took place in Trans-Pecos Texas during the Oligocene epoch produced mostly silicic rock. The great Rim Rock fault was subsequent to most of the volcanism, but olivine basalt came up along the fault; a small basalt flow is interbedded in the lower part of the Tarantula gravel. The outcrops of typical Tarantula gravel are relics of a bajada gravel that was shed westward from the high scarp of the Rim Rock fault. The Tarantula may be contemporaneous with other ancient post-volcanic gravels. Renewed faulting displaced the Tarantula.--Auth.

-871. Doering, John A. QUATERNARY SURFACE FORMATIONS OF SOUTHERN PART OF TLANTIC COASTAL PLAIN: Jour. Geology, v. 68, o. 2, p. 182-202, 12 figs. incl. 4 fold. maps, secs., old. diag., March 1960, 25 refs.

The Citronelle formation of the eastern Gulf Coast region extends northward across the coastal plains of Georgia, South Carolina, North Carolina, and Virginia as a gravelly sand formation 100 ft. thick, covering 30,000 sq. mi. of upland area. These deposits were shown on early geological maps as the "Lafayette" or "Altamaha" formation, of late Pliocene or early Pleistocene age. In more recent geological reports the deposits have been ignored or included in the underlying Tertiary and Cretaceous formations; miscorrelations at state boundaries are involved in these later interpretations.

Determinations of "older than (Nebraskan) Pleistocene" made on plant fossils found in the surface Citronelle in Alabama and the presence of Calabrian index fossils, the cold-water Foraminifera, *Hyalinea balthica*, and *Globigerina inflata*, in the subsurface Citronelle in southern Louisiana, indicate an early Pleistocene (preglacial) age for the formation.

Deposition of the formation in the Atlantic Coast region occurred on a peneplain developed during a tectonically quiet time in the late Miocene and Pliocene and was caused by the first of a series of uplifting and warping movements which affected the coastal and adjacent mountain regions. These movements, which separate the present cycle of erosion and deposition from the preceding period of peneplanation, provide a sounder geological basis for the division of the Tertiary and Quaternary periods than does the post-Citronelle initiation of Pleistocene glacial climate.--Auth.

2-872. Howard, Hildegarde. SIGNIFICANCE OF CARBON-14 DATES FOR RANCHO LA BREA: Science, v. 131, no. 3402, p. 712-714, March 11, 1960, 7 refs.

Beginning with a brief historical background of the early scientific studies at La Brea, California, the author traces the problems encountered in the various traps. The most important point in this consideration is the fact that due to the intermittent movements of the tar from below, the fossils have been moved out of their usual stratigraphic positions and are now mixed together to a greater or lesser degree in different places. Dating of the wood of a tree which occupied a stable position in one trap gave values from 13,890 ± 280 years to 15,390 ± 230 years. All around this still-rooted fossil tree were many fossil animals in what seemed unmoved order. The range of the age of the tree was considerably more recent than the usual 50,000 years commonly given in this area. The mobility of stratum because of tar movement must be carefully observed before any age relationship is established.--C. W. Schreiber.

2-873. Moore, J.M., Jr., S.R. Hart, C.C. Barnett, and Patrick M. Hurley. POTASSIUM-ARGON AGES IN NORTHERN MANITOBA: Geol. Soc. America, Bull., v. 71, no. 2, p. 225-229, 2 maps, table, Feb. 1960, 19 refs.

The boundary between the rocks of the Churchill (Athabasca) and Superior geologic provinces is considered to be along the Nelson River valley in Manitoba. To test this conclusion isotope ages of rocks in these areas were determined to learn if there were significant differences in ages between provinces. In addition, the homogeneity of the ages within a single orogenic province was of interest to the investigators. The Ar analyses were made by isotope dilution method, and K analyses were made using a Perkins-Elmer flame photometer. The analytical error associated with the measurements is approximately 3%. The results suggest that the Churchill province is homogeneous, ranging from 1,640 to 1,800 million years. These results agree favorably with U-Pb ages determined previously by other work in Saskatchewan and the Northwest Territories (1,700 to 1,900 million years). Age determinations in the Superior province are typical of "mixed-age" areas which result from partial or complete recrystallization of older rocks in the vicinity of younger orogenic belts. The ages (1,640 to 2,200 million years) are interpreted as indicating that the normal host rock in the area sampled should be included in the Superior province, although they are well below the usual 2,400 to 2,600 million years determined by U-Pb and Rb-Sr methods in southeastern Manitoba and northwestern Ontario. A younger bordering orogeny will expose rocks from depth in which metamorphism of varying degrees will produce heterogenity that may be very broad or local in scale.--B. W. Pipkin.

2-874. **Cobb, James C., and J. Laurence Kulp. U-Pb AGE OF THE CHATTANOOGA SHALE: Geol. Soc. America, Bull., v. 71, no. 2, p. 223-224, table, Feb. 1960, 6 refs.**

The absolute age of the upper black unit of the Gassaway member of the Chattanooga shale was determined by isotopic methods. A 4.9-ft. section of the shale was taken from a drill core obtained in the Youngs Bend area, Tennessee. Three samples were analyzed by isotope dilution techniques. The $U^{238}$-$Pb^{206}$ ages on all 3 samples agree within their experimental errors. The average of 2 samples with reasonably small errors gives an apparent age of 350 ± 10 m.y. In relating this apparent age to the true age of the uppermost Devonian Gassaway member, chemical alterations in this type of environment was considered. Alteration, if present, normally consists of loss of bulk Pb and/or preferential loss of $Pb^{206}$. In Swedish black shales, high Pb contents were due to movement of $Pb^{206}$ from U "hot spots" into the shale. No such "hot spots" appear to be present in the Chattanooga shale, so that this effect would be negligible. Therefore, at worst, it would appear that 350 ± 10 m.y. for the Chattanooga shale should be a reliable minimum figure.--B. W. Pipkin.

2-875. **Jäger, Emilie, and Henry Faul. AGE MEASUREMENTS ON SOME GRANITES AND GNEISSES FROM THE ALPS: Geol. Soc. America, Bull., v. 70, no. 12, pt. 1, p. 1553-1557, map, 2 tables, Dec. 1959, 18 refs.**

K/Ar and Rb/Sr age measurements are reported on samples from 3 geologic units from the Alps of Switzerland and northern Italy. The results: Baveno granites of Lago Maggiore, 268-291 million years; Aare massif in Bernese Oberland, 23(?)-78 m.y.; Ticino gneiss of Val Verzasca, 17-19 m.y.--M. Russell.

2-876. **Faul, Henry, P.L.D. Elmore, and W.W. Brannock. AGE OF THE FEN CARBONATITE (NORWAY) AND ITS RELATION TO THE INTRUSIVES OF THE OSLO REGION: Geochim. et Cosmochim. Acta, v. 17, no. 1/2, p. 153-156, Aug. 1959, 14 refs**

K/Ar age determinations were made on biotite from the Fen area and from the post-Carboniferous Drammen granite in the Oslo region. In addition, Pb alpha age determinations on a zircon from a Fen carbonatite were carried out, and U/Pb isotopic ratios were measured on zircons from the Oslo nordmarkite.

The results showed ages of 565 and 530 million years for the Fen carbonatites, a minimum of 259 m.y. for the Drammen granite, and 259 and 216 (questionable) m.y. for the Oslo nordmarkite. The results also confirm the early suggestion of Brøgger that the Fen carbonatites represent an older event than the Oslo rocks. --F. Manheim.

## 5. PALEONTOLOGY

See also: Stratigraphy 2-868, 2-872; Geochemistry 2-916.

2-877. **Keosian, John. ON THE ORIGIN OF LIFE: Science, v. 131, no. 3399, p. 479-482, Feb. 19, 1960, approx. 35 refs.**

"The theory of evolution holds that all living things are interrelated by common descent from an original case of successful biopoesis. A plausible explanation of how biopoesis may have taken place has been developed over the past 2 or 3 decades. Somewhat modified, this explanation can be marshaled in support of the hypothesis that neobiogenesis has been a continuing possibility since life first originated. The rejection of this possibility on the grounds that the conditions which established life no longer exist is not entirely justified." This presentation is detailed with historical background and biochemical detail as well as an ecological view of the matter.--From auth.

2-878. **Roach, A.W., and J.K.G. Silvey. THE OCCURRENCE OF MARINE ACTINOMYCETES IN TEXAS GULF COAST SUBSTRATES: Am. Midland Naturalist, v. 62, no. 2, p. 482-499, 7 figs., Oct. 1959, 18 refs.**

Hydrography of the barrier bar-lagoon development between the Louisiana and Mexico borders is discussed as it pertains to entrapment of marine and human wastes, seasonal and areal changes in salinity and the occurrence of marine actinomycetes. Hypersaline habitats exist from Corpus Christi southward and hyposaline habitats eastward due to the disposition of the Rocky Mountain barrier across the northwesterlies and the movements of the Gulf tropical air mass. The greater percent of actinomycetes isolated were from organic substrates in unpolluted hyposaline stations.--A. W. Roach.

2-879. **Berry, William B.N. GRAPTOLITE FAUNAS OF THE MARATHON REGION, WEST TEXAS: Texas, Univ., Pub. 6005, 179 p., 3 figs., 20 pls., March 1960, 202 refs.**

In the Marathon region, graptolites have been foun throughout a 2,000-ft. section of limestones and shales from the base to the top of the Ordovician system. This is the most complete sequence of Ordovician graptolites known in North America. Fifteen faunal zones are recognized. This region will provide a standard section against which other graptolite bearing formations may be compared.

Other graptolite-bearing formations in North America are correlated with the Marathon zones.

Further, the Marathon zones are correlated with the British and Australian Ordovician graptolite zonal successions. The zonal assemblages in the Marathon region for the Lower and lower part of the Middle Ordovician are similar to the Australian but differ from the British. The upper part of the Middle Ordovician and the Upper Ordovician assemblages are nearly identical in all 3 zonal sequences.

The report includes an extension of detailed stratigraphic study to lesser-known areas SE. and SW. from the Marathon basin. P. B. King mapped the basin in detail and recognized 5 Ordovician formations. From oldest to youngest these are the Marathon limestone, Alsate shale, Fort Peña formation, Woods Hollow shale, and Maravillas chert. The boundaries of the Marathon limestone and Alsate shale are modified from King's usage. Also, a progressive change to a more arenaceous nature southward from the basin is noted for the lower part of the section, and a new formation, the Rodriquez Tank sandstone, is recognized in the southern exposures.

The stratigraphic position of every species of graptolite found in the Marathon region is correlated with occurrences of these species elsewhere in North America and in England and Australia. Seven new species of graptolites are described.--Auth.

2-880. Squires, Donald F. **RESULTS OF THE PURITAN-AMERICAN MUSEUM OF NATURAL HISTORY EXPEDITION TO WESTERN MEXICO. 7. CORALS AND CORAL REEFS IN THE GULF OF CALIFORNIA:** Am. Mus. Nat. History, Bull., v. 118, art. 7, p. 371-431, 7 pls., 16 maps, chart, 5 secs., 7 tables, 1959, 58 refs.

Fossil and Recent corals and coral reefs of the tropical eastern Pacific are considered zoogeographically, ecologically and taxonomically. Affinities between the West Indian coral faunas and those existing today in the eastern Pacific are considered with relation to the presence of past interconnections between the Atlantic and Pacific. Close relationships such as those exhibited by the Imperial Valley fauna ceased in the lower Pliocene, the earliest appearance of the modern fauna being middle Pliocene. Migration of species and morphotypes during the Pleistocene are considered, the effect in the Gulf of California being small. The ecologies of Pliocene, Pleistocene, and modern reefs are compared and shown to be very similar. Several reef types, developed under marginal ecological conditions are defined. --Auth.

2-881. Drake, Robert J. **NONMARINE MOLLUSCAN REMAINS FROM RECENT SEDIMENTS IN MATTY CANYON, PIMA COUNTY, ARIZONA:** Southern California Acad. Sci., Bull., v. 58, pt. 3, p. 146-154, illus., map, 3 tables, Sept.-Dec. 1959, pub. Jan. 1960, 3 refs.

Three hundred and fifty molluscan shells from 14 sediment samples from Recent deposits in Matty Canyon, southeastern Pima County, were studied as to abundance of shells, proportion of each form or general taxonomic type, and the implied environmental conditions under which they had lived. Mollusks from 13 of the 14 samples gave indications of some shallow water (pond, marsh, and/or slow moving stream) habitat. Landsnail material in 12 of the 14 samples gave indication of probable grassland and/or moderate vegetation cover. In the molluscan material there was no indication of forms common to heavy vegetation cover or rushing rivers. In general, the mollusks reflected conditions akin to modern ones, prior to the present arroyo cutting situation. The period covered by the sediment samples represented ca. 3,250 years before the present.--Auth.

2-882. La Rocque, J. A. Aurèle. **MOLLUSCAN FAUNAS OF THE FLAGSTAFF FORMATION OF CENTRAL UTAH:** Geol. Soc. America, Mem. 78, 100 p., 3 pls., 3 tables, 1960, 55 refs.

The Flagstaff formation of central Utah is divided into 3 units; the lowest is Paleocene, the middle is Paleocene or Eocene, and the upper is Eocene. The lowest unit contains 28 species of fresh-water and land Mollusca; the middle unit contains 2 species of land snails; the upper unit contains 13 species of fresh-water and land Mollusca. The total molluscan fauna consists of 37 species - 5 fresh-water pelecypods, 24 fresh-water gastropods, and 8 land gastropods. Four new species are described: Elliptio mormonum, Lampsilis spiekeri, Hydrobia ephraimensis, and Carinulorbis utahensis. The quantitative and volumetric abundance of each species is given. The paleoecology of the lake is examined from the following standpoints: size of the lake, depth of water, chemical composition of the water, fluctuations of the shore line, surrounding land surface, source of sediments, nature of sediments, wave action, evaporation, vegetation, composition and variation of the molluscan fauna. The history of the lake is described from its origin in late Paleocene time to its extinction in Eocene time. In the first phase, the lake was small, with abundant vegetation and a large molluscan fauna. In its second phase, it deepened and expanded considerably; the gypsum content of its waters increased, and the molluscan fauna was wiped out; only land snails and fragments of molluscan shells were preserved. In the third phase, the lake was still large but shallow; a new molluscan fauna invaded the lake and persisted until its extinction. The Flagstaff lake was partly wiped out by encroachment of alluvial-plain sediments and partly merged with the Green River lake which spread into its area from the N.--Auth.

2-883. Fritz, Madeleine A. **MERASPID PERIOD (DEGREE 3) OF PSEUDOGYGITES LATIMARGINATUS (HALL):** Can. Jour. Zoology, v. 37, no. 6, p. 1117-1121, 2 illus., table, Dec. 1959, 8 refs.

A specimen approximately 4 mm. in length from the Craigleith formation (upper Middle Ordovician) on the shore of Georgian Bay near Craigleith represents degree 3 of the Meraspid period of the species Pseudogygites latimarginatus (Hall). The species is the characteristic index fossil found at the above horizon not only on Georgian Bay but elsewhere. Adult specimens occur in great abundance in southern Ontario, but no larval stages have been described. The present specimen is of special interest in that it furnishes significant information on the ontogeny of a widely known species.--Auth.

2-884. Ricker, Karl E. **THE ORIGIN OF TWO GLACIAL RELICT CRUSTACEANS IN NORTH AMERICA, AS RELATED TO PLEISTOCENE GLACIATION:** Can. Jour. Zoology, v. 37, no. 6, p. 871-893, 4 maps, 2 graphs, Dec. 1959, 75 refs.

In North America Mysis relicta and Pontoporeia affinis occur almost exclusively in basins which were part of a proglacial lake during late glacial time.

They also occur in arctic brackish waters, and arctic stocks can have served as the origin of all inland continental stocks, provided the ice advanced originally from the NE. across such shallow seas as Foxe Basin and Hudson Bay - in the manner envisaged by Flint's recent hypothesis of how the continental ice sheet was established. On this view, the future relicts were carried across the continent in proglacial lakes as the ice advanced as far as the Waterton Lakes in Alberta-Montana and the Finger Lakes in New York; during the retreat of the ice, they followed its margin back in a similar series of lakes, remaining in the survivors of the latter whenever they are deep and cold enough.--Auth.

2-885. Colbert, Edwin H. DINOSAURS. 7th ed.: Am. Mus. Nat. History, Sci. Guide no. 70, 32 p., 28 illus., map, 2 charts, 2 tables, 1959, 6 refs.

The following topics are discussed in this booklet: what is a dinosaur?, primary classification of the dinosaurs, geologic time, geologic and geographic distribution of the dinosaurs, ancestors of the dinosaurs, Triassic, Jurassic, and Cretaceous dinosaurs, the end of the dinosaurs, dinosaurs in the field and laboratory.

2-886. Robinson, Peter. SINOPA FROM THE CUCHARA FORMATION OF COLORADO: Yale Univ., Peabody Mus. Nat. History, Postilla no. 44, p. 1-4, fig., Feb. 15, 1960, 5 refs.

The presence of Sinopa cf. vulpecula Matthew 1915, family Hyaenodontidae, suborder Credonta, order Carnivora, is recorded from the Cuchara formation, near La Veta, Huerfano County, Colorado. This specimen is the third collected from this formation. The other 2 represent different genera and have been lost. The skull, in part, and the upper teeth are described. Comparison of this form with Sinopa from the Big Horn basin and other areas indicate an age for the Cuchara formation of early Eocene and possibly late early Eocene. Measurements of the specimen are given.--J. J. Stephens.

2-887. McKenna, Malcolm C. TAPOCHOERUS, A UINTAN DICHOBUNID ARTIODACTYL FROM THE SESPE FORMATION OF CALIFORNIA: Southern California Acad. Sci., Bull., v. 58, pt. 3, p. 125-132, 3 illus., Sept.-Dec. 1959, pub. Jan. 1960, 6 refs.

Hyopsodus egressus Stock from the Uintan (late Eocene) Tapo Ranch faunule, Sespe formation, southern California, is not a hyopsodont condylarth. The species is here made the type of Tapochoerus, new genus, a dichobunid artiodactyl. A hypocone and non-hypertrophied metaconule on the upper molars and the lack of a metaconid on $P_3$, combined with presence of a metaconid on $P_4$, a paraconid on $M_1$ and $M_2$, and the nature of the lower molar hypoconulids, indicate affinity with the most primitive members of the dichobunid subfamily Homacodontinae. The recently proposed dichobunid subfamily Antiacodontinae Gazin is rejected and its members returned to the Homacodontinae.--Auth.

2-888. Pessagno, Emile A., Jr. STRATIGRAPHY AND MICROPALEONTOLOGY OF THE CRETACEOUS AND LOWER TERTIARY OF PUERTO RICO: Micropaleontology, v. 6, no. 1, p. 87-110, 5 pls., map, 3 charts, diag., Jan. 1960, 22 refs.

A preliminary survey of the stratigraphy, paleoecology, and micropaleontology of the Cretaceous and lower Tertiary rocks of southwestern Puerto Rico is presented. A local system of zonation based on planktonic Foraminifera is proposed for the Campanian and Maestrichtian. The stratigraphy and paleoecology of the major formational units are briefly discussed. Six new species and 1 new subspecies are described.--Auth.

2-889. Cookson, Isabel C., and Alfred Eisenack. MICROPLANKTON FROM AUSTRALIAN CRETACEOUS SEDIMENTS: Micropaleontology, v. 6, no. 1, p. 1-18, 6 illus., 3 pls., Jan. 1960, 5 refs.

Sixteen new genera and 43 species, of which 31 are new, of microplankton are described from western Australian Cretaceous (Albian to Campanian) sediments. The new forms include dinoflagellates, hystrichospheres, and others of uncertain affinity.--Auth.

2-890. Banner, F. T., and Walter H. Blow. THE TAXONOMY, MORPHOLOGY AND AFFINITIES OF THE GENERA INCLUDED IN THE SUBFAMILY HASTIGERININAE: Micropaleontology, v. 6, no. 1, p. 19-31, 11 illus., Jan. 1960, 8 refs.

The taxonomy, morphology, and affinities of the subfamily Hastigerininae are discussed. Lectotypes have been designated and described for Globigerina siphonifera d'Orbigny and Globigerina aequilateralis Brady, whilst a neotype has been designated for Nonionina pelagica, this same neotype also standing as lectotype for Hastigerina murrayi Thomson. The morphology of the genus Hastigerinella Cushman 1927 is discussed, and a reinterpretation of Rhumbler's figure of the type species, Hastigerina digitata Rhumbler, is given, based on examination of Recent conspecific material. A new subgenus of Globorotalia Cushman 1927, Globorotalia (Beella) n. subgen., is proposed. The classification of the Globorotaliinae and Hastigerininae is revised, and the interrelationships of their genera and subgenera are re-examined in the light of the authors' previous work. The iteration of biocharacters, especially the character of digitate, radially elongate chambers, within the Globigerinaceae, is discussed.--Auth.

2-891. Hofker, Jan. THE GENUS TRUNCOROTALIA CUSHMAN AND BERMUDEZ, 1949: Micropaleontology, v. 6, no. 1, p. 111-115, 10 illus., Jan. 1960, 12 refs.

The genus Truncorotalia Cushman and Bermudez may have developed from the genus Globorotalites. The genotype, Rotalina truncatulinoides d'Orbigny, shows different development of the umbilical cavity, from an open to a totally closed cavity, in specimens from different localities. Thus, it is possible that several fossil species of Globorotalia with a flat dorsal side and a more or less closed umbilicus belong to the genus Truncorotalia. In that case, a closely related series of forms ranges from the uppermost Maestrichtian (or Danian) [Cretaceous] up to the Recent. The new genus Conorotalites Kaever is synonymous with Globorotalites.--Auth.

2-892. Barnard, Tom. SOME SPECIES OF LENTICULINA AND ASSOCIATED GENERA FROM THE LIAS OF ENGLAND: Micropaleontology, v. 6, no. 1, p. 41-55, chart, 7 pls., Jan. 1960, 32 refs.

The trends in variation of the different species groups of Lenticulina from the Lias are shown. The plexus of evolving forms is discussed, and the stratigraphical significance of the various species groups is given. The gradation from the coiled lenticuline to an uncoiled at flabelline stage is demonstrated. The evolutionary, biological and stratigraphical aspects are stressed rather than the purely taxonomic approach. Some forms described by other authors are discussed, but a complete synonymy is not attempted.--Auth.

2-893. Green, Keith E. ECOLOGY OF SOME ARCTIC FORAMINIFERA: Micropaleontology, v. 6, no. 1, p. 57-78, 6 illus. on pl., 2 maps, sec., chart, 4 diags., graph, 6 tables, Jan. 1960, 59 refs.

An investigation of the Foraminifera in cores of the bottom sediments of the central Arctic Ocean indicates significant quantitative trends in this relatively uniform environment. Foraminiferal occurrences are compared with sediments, sea-floor topography, water depth, calcium carbonate distribution, organic C content of the sediments, temperature and salinity of the water, and associated organisms. A total of 105 species of Foraminifera, of which 20 were useful in establishing depth zones, were collected at depths between 433 and 2760 m. Five species and 1 variety are new. Faunal changes correspond generally to changes in slope. Application of the data suggests displacement of the sediments in parts of some cores.--Auth.

2-894. Tynan, Eugene J. THE ARCHAEOMONADACEAE OF THE CALVERT FORMATION (MIOCENE) OF MARYLAND: Micropaleontology, v. 6, no. 1, p. 33-39, 15 illus. on pl., Jan. 1960, 15 refs.

The Archaeomonadaceae of the Calvert formation (Miocene) were studied morphologically and taxonomically. Two genera with 15 species, 4 of which are new, are described and illustrated. A history of the study of the group with a review of the existing genera is given.--Auth.

2-895. Baker, George. FOSSIL OPAL-PHYTOLITHS: Micropaleontology, v. 6, no. 1, p. 79-85, 3 illus., table, Jan. 1960, 7 refs.

The discovery of fossil opal-phytoliths in several Tertiary and Quaternary sediments of Victoria [Australia] shows that they resisted mechanical and chemical weathering during deposition. They survived several million years without being severely corroded or transformed by hydration to either chalcedony or quartz during the diagenesis of sedimentation. Fossil as well as recent plants secreted opal-phytoliths. Their presence in sediments serves as an indicator of certain plant groups, grasses, reeds and their allies, where recognizable remains or macerated debris did not survive.--Auth.

2-896. GINKGO BILOBA L: HISTORICAL SUMMARY AND BIBLIOGRAPHY: Virginia Jour. Sci., v. 10, no. 3, p. 131-176, July 1959, approx. 550 refs.

Ginkgo antedates the formation of the Rocky Mountains and the Urals. It has extraordinary vitality, adaptability, and resiliency to changing environment. Its bark is remarkably tough and its leaves resistant to insect pests. It can withstand temporary drought and fire. It crossed the temporary land bridge between Asia and America by way of Alaska and Siberia and possibly another by way of Greenland and Franz Joseph Land. The bibliography encompasses all literature of Ginkgo from general paleobotanical and historical works to research investigations on taxonomy, morphology, reproductive system, cytology, chemistry, pharmacology and horticulture. It includes essentially the research published during the years 1880 to the summer of 1958.--M. Russell.

2-897. McCall, J. Mabel. FOSSILS OF HUMBOLDT COUNTY: Gems & Minerals, no. 268, p. 28-29, 82, 5 illus., map, Jan. 1960.

General comments on fossil collecting. A few of the fossils found in Humboldt County, California, are: Pecten caurinus, Pecten crassicardo, Securella staleyi, Cardium meekianum, Chrysodomus stantoni, Argobuccinum arnoldi, Dendraster oregonensis, and Chione securis.--J. Sinkankas.

## 6. GEOPHYSICS

See also: Geologic Maps 2-791 through 2-807, 2-816; Areal and Regional Geology 2-836; Geomorphology 2-854; Structural Geology 2-860; Fuels 2-995, 2-996.

2-898. Kindij, Eugene. DISCUSSION OF THE ELECTROSEISMIC EFFECT: Geophysics, v. 25, no. 1, p. 325, Feb. 1960.

Commenting on the paper by Martner and Sparks on the electroseismic effect [GeoScience Abstracts 1-1194], Kindij points out the possibility of using the method to determine permeability of formations other than the weathering zone. The first attack might be on cores; an acoustic source applied on the core would create potentials that could be measured, and the measured amplitudes should be directly related to permeability. At present, the weak acoustic sources available would hardly give measureable electric potentials in boreholes. Further research on this application is suggested.--D. B. Vitaliano (courtesy Geophysical Abstracts).

2-899. Myers, W.H. OBTAINING GEOLOGICAL DATA FROM SEISMOGRAMS: Oilweek, v. 10, no. 43, p. 32-37, Dec. 11, 1959.

Determination of accurate travel times to acoustic horizons permits preparation of structure and isopach maps. Qualitative study of energy bands differentiates between true and extraneous reflections.--Worldwide Oil & Gas Abstracts, v. 5, no. 1, p. 21, Jan.-Feb. 1960, abs. 51-7. 5.

2-900. Rexin, Elmer E. A WELL WATER SEISMOMETER: Earth Sci., v. 13, no. 1, p. 15-18, 29, illus., chart, log, graph, Feb. 1960.

The water level in the well of the Nunn-Bush Shoe Company, Milwaukee, Wisconsin, responds to earthquake waves, and a seismometer especially designed to record these fluctuations in level has been in operation for 12 years. The well was drilled to a depth of 400 ft. into the Silurian Niagara dolomites; it has a 10-in. casing from surface to 104 ft., an 8-in. casing to 215 ft., and uncased from there to bottom; present level of the water is 93.5 ft., from ground surface. The largest quake recorded, the Assam-Tibet quake of 1950, caused an oscillation of 11.9 ft. The Hebgen Lake quake of Aug. 1959 caused an oscillation of 2.5 ft. A probable explanation of the action of the well is that the well connects with a fault formed when the Porcupine Mountains of northern Michigan were active volcanoes. The fault may be filled with water, and as the quakes occur the action would be analagous to pressures on a syringe bulb (the fault) causing exaggerated movement in an attached thin tube (the well).--M. Russell.

**2-901. Oakeshott, Gordon B., *ed.* SAN FRANCISCO EARTHQUAKES OF MARCH 1957: California, Div. Mines, Spec. Rept. 57, 127 p., 52 illus., 58 figs., 9 tables, 1959, refs.**

*Contains*: Preface, by Gordon B. Oakeshott; San Andreas fault in Marin and San Mateo counties, by Gordon B. Oakeshott; Geologic observations in the epicentral area of the San Francisco earthquake of March 22, 1957, by M. G. Bonilla; Seismic history of the San Francisco region, by Don Tocher; Intensity and ground motion of the San Francisco earthquake of March 22, 1957, by William K. Cloud, with notes on remeasurement of triangulation net in the vicinity of San Francisco, by Charles A. Whitten; Seismographic results from the San Francisco earthquakes of 1957, by Don Tocher; Damage to buildings and other structures of the San Francisco earthquake on March 22, 1957, by Karl V. Steinbrugge, Vincent R. Bush, and Edwin G. Zacher; Effect of the San Francisco earthquake of March 22, 1957 on public schools, by Manley W. Sahlberg; Response spectrum analysis of March 22, 1957, San Francisco earthquake, by D. E. Hudson and G. W. Housner.

The San Francisco earthquake of March 22, 1957 was a minor one in an area long known to be seismically active. Nevertheless, it was the strongest and most damaging shock San Franciscans have felt since the great earthquake of Apr. 18, 1906. Although quite different in the amount of energy involved, nature of earth movement, and geologic surface effects, both apparently originated on the same segment of the San Andreas fault. This fault - California's most widely known structural geologic feature - has a history of repeated displacements which have caused many earthquakes along its 650-mi. length in the state.

Epicenter of the main shock was 37°40'N. 122°29'W., origin time 11:44:21.0 P. S. T., and magnitude was 5.3. Epicenter was in the San Andreas rift zone near Mussel Rock. The fault-plane solution based on first motions suggests the continental side of the fault moved upward relative to the Pacific side. The main shock was felt over a land area of about 12,000 sq. mi. and was of maximum Modified Mercalli scale intensity 7 near the epicenter; duration of stronger accelerations was not over 5 seconds.

Most concentrated damage to buildings occurred in the Westlake district which is underlain by soft sediments of Pliocene to Recent age. The San Andreas fault is about 0.8 mi. S. of Westlake. Landslides occurred along the steep sea cliffs and along the shores of Lake Merced; there was no surface fault movement. Overall loss to buildings and other structures has been estimated at about $1 million. Strong-motion accelerometer records were obtained from 5 stations located in San Francisco and Oakland. Ground motion in this earthquake was somewhat different from most recorded strong-motion earthquakes, in that the time durations were relatively short and peak accelerations were large for a shock of this magnitude.--G. B. Oakeshott.

**2-902. Lehmann, I. VELOCITIES OF LONGITUDINAL WAVES IN THE UPPER PART OF THE EARTH'S MANTLE: Canada, Dominion Observatory, Pub., v. 19, no. 10, p. 381-406, 3 diags., 5 tables, [1959? ], 19 refs.; *reprinted from*: Annales de Géophysique, t. 15, p. 93-118, 1959; abs. in English and French.**

The investigation deals with Europe only and recalls the complexity of its structure. Because the *P* time-distance curve is now taken to be nearly a straight line up to about 15° epicentral distance, the velocity at depth cannot be derived from it by the direct method, but by trial and error a possible solution is obtainable. The velocity gradient has to be taken quite small or zero in an upper layer. This was taken to extend to 220 km. depth and an abrupt increase of velocity and velocity gradient to set in at this depth. From about 15° onwards the *P* curve becomes associated with waves refracted in the deeper layer.

The velocities... adopted [are given in a table]. Up to 22° the corresponding *P* curve is in good agreement with Jeffreys' revised 1954 curve.

The properties of *P* and *pP* curves of shocks having their foci at some depth in the upper layer were considered. Some deep Romanian earthquakes all from the same focus were examined and their *P* times compared with those calculated. Some deviations seemed explainable only as due to local differences of structure. A deep earthquake in the Tyrrhenian Sea was also examined.

The adopted solution seems a possible one, but it is not unique and more observations are required. More precise determinations of amplitude variation would be particulary useful.--Auth.

**2-903. Westby, Gerald H. GEOPHYSICS AND STRATIGRAPHIC PROBLEMS: 30 p., 29 figs. incl. illus., map, diag., logs, profiles, Tulsa, Oklahoma, Seismograph Service Corporation, [1959], 14 refs.**

This paper was first presented as a Distinguished Lecture under the auspices of the American Association of Petroleum Geologists in the period Sept. 22 to Nov. 15, 1958, before geological and geophysical societies and university groups in the United States and Canada.

Of the three principal geophysical methods of oil prospecting - magnetic, gravity, and seismic - the last shows the best promise for locating stratigraphic traps. Isochron maps, prepared from reflection seismic surveys, have been instrumental in outlining numerous traps. The continuous velocity log shows a definite relationship between velocity and the geologic age of the formation; changes in porosity are also recorded. The theory of velocity logging is explained. The variable density cross-section permits the easy scanning of many seismic records for the recognition of the continuity of reflections.--M. Russell.

**2-904. Bonini, William E., and George P. Woollard. SUBSURFACE GEOLOGY OF NORTH CAROLINA-SOUTH CAROLINA COASTAL PLAIN FROM SEISMIC DATA: Am. Assoc. Petroleum Geologists,**

**Bull., v. 44, no. 3, pt. 1, p. 298-315, 5 figs. incl. 2 maps, secs., 2 diags., table, March 1960, 25 refs.**

Sixty new seismic-refraction measurements on the Coastal Plain of North Carolina and South Carolina were made to fill gaps in existing well and geophysical data and to make a more comprehensive study of the nature and structure of the Coastal Plain floor. Thirty-nine measurements were made on the adjoining Piedmont province to determine seismic velocities of specific rock types, thus aiding the assignment of lithologic types to basement velocities observed on the Coastal Plain.

Seismic velocities observed for gneiss, schist, slate, and granitic rocks range from 15,900 ft. per sec. to 19,200 ft. per sec. (4.8 to 5.8 km./sec.); diabase velocities averaged 22,500 ft. per sec. (6.8 km./sec.); Triassic sediments from 10,400 to 14,500 ft. per sec. (3.2 to 4.4 km./sec.); and the highest velocity correlated with Cretaceous Coastal Plain sediments is 9,600 ft. per sec. (2.9 km./sec.).

The following conclusions are based on these studies. 1) Because basement lithologic trends and velocities are similar to those in the Piedmont, confirmed by deep wells, it is apparent that the Piedmont complex extends under the Coastal Plain sediments as far E. as the present coast. 2) The Carolina Slate belt extends under the Coastal Plain and reaches a maximum width, 80 mi., in North Carolina, though the Triassic Deep River basin is in the middle. An eastern slate belt with NE. strike is postulated midway between the Fall Line and the coast under the Coastal Plain sediments. 3) The buried Florence Triassic basin is approximately 40 mi. long on an ENE. strike and limited in width to 13 mi. A new buried Triassic basin is postulated to extend from near Raeford into Johnson County, North Carolina. 4) The Cape Fear arch is a prominent basement structure with a seaward slope of 13 ft. per mi. on the axis. It is not reflected in the sea level basement surface contour near the Fall Line. Sedimentary record suggests differential movement at least twice since Cretaceous time. 5) The pre-Cretaceous basement is a surface of erosion with topographic relief on the order of 200 ft. 6) The break in basement slope in eastern North Carolina must be projected seaward of Cape Fear and the South Carolina coast. 7) There is the suggestion of an E.-W. syncline superimposed on the steeper basement slope in eastern North Carolina, and its existence is supported by a similar structure in the Coastal Plain sediments based on an earlier seismic-reflection survey. --Auth.

**2-905. Telfair, David, Robert Garrison, and Carl Smith. NATURAL RADIOACTIVITY OF MIAMI SOILS: Science, v. 131, no. 3402, p. 727-728, March 11, 1960, 7 refs.**

An important part of man's radioactive environment is the natural radioactivity of soils. This radioactivity varies with soil type and with depth in the soil profile. The relation between gross gamma activity and soil depth for a particular soil (Miami silt loam) is presented, together with a discussion of the contribution of $K^{40}$ and the U and Th series and of the effects of fallout from bomb tests in increasing the radioactivity of a thin layer of surface soil.--Auth.

**2-906. Jones, Charles L., C.G. Bowles, and K.G. Bell. EXPERIMENTAL DRILL HOLE LOGGING IN POTASH DEPOSITS OF THE CARLSBAD DISTRICT, NEW MEXICO: U.S. Geol. Survey, Repts., Open-File Ser., [no. 502], 22 p., sec. (in pocket), 4 diags. (in pocket), table, [Jan. 1960], 8 refs.**

Experimental logging of holes drilled through potash deposits demonstrate the considerable utility of gamma-ray, neutron, and electrical resistivity logging in the search for and identification of mineable deposits of sylvite and langbeinite. Such deposits are strongly radioactive with both gamma-ray and neutron well logging. Their radioactivity serves to distinguish them from claystone, sandstone, and polyhalite beds and from potash deposits containing carnallite, leonite, and kainite. These latter strata and deposits are radioactive with gamma-ray logging but yield no radiation with neutron logging. Porous beds, such as sandstone strata, and solution cavities, such as those commonly formed in potash deposits by rotary drilling of evaporites, are less resistive than other materials. Low resistivity provides a means for differentiating between potash deposits and polyhalite beds on electrical resistivity logs of holes drilled with fresh-water and salt-base muds.--Auth.

**2-907. McNitt, James R. GEOTHERMAL POWER: California, Div. Mines, Mineral Inf. Service, v. 13, no. 3, p. 1-9, 4 illus., 3 maps, 2 diags., graph, March 1960, 16 refs.**

Natural steam is currently being used to generate electric power in Italy, New Zealand, Russia, and Mexico. In the spring of 1960 a 12,500-kw. geothermal steam-electric generating plant will go into operation in the northern California Coast Ranges.

As in the Italian and New Zealand thermal areas, recent volcanism and faulting characterize the occurrence of steam in the California region, which is located approximately 100 mi. N. of San Francisco. Here a right-lateral fault zone in the Jurassic-Cretaceous rocks of the Franciscan formation controls the occurrence of fumaroles and hot springs. Plio-Pleistocene volcanic rocks occupy a large area only a few miles to the NE. of the fault zone. A convective system is believed to carry meteoric water downward into contact with hot, residual volcanic rocks where it is heated and mixed with volcanic gases. Tensional fissures, developed in the fault zone, then conduct the thermal fluid back to the surface.

The steam is utilized by drilling wells approximately 800 ft. deep into a fumarole area and piping the steam directly into a turbine, which will operate at 100 p.s.i.g. and 348°F. The California steam is especially suitable for use in a turbine because its noncondensable gas content is only 0.75% by weight, which is considerably lower than the noncondensable gas content of the Italian steam, and it contains 11°F. superheat so that a gas-liquid separation is not required as with the saturated steam used in New Zealand.--Auth.

# 7. GEOCHEMISTRY

See also: Stratigraphy 2-873, 2-874, 2-876; Mineralogy 2-920, 2-923.

2-908. Gilbert, M.A. FIELD AND LABORATORY METHODS USED BY THE GEOLOGICAL SURVEY OF CANADA IN GEOCHEMICAL SURVEYS. NO. 1. LABORATORY METHODS FOR DETERMINING COPPER, ZINC, AND LEAD: Canada, Geol. Survey, Paper 59-3, 21 p., 1959, 5 refs.

Preliminary series paper outlining the procedure used by the Geological Survey of Canada in determining Cu, Zn, and Pb from stream sediments and rock samples, both in the field and laboratory. This is intended as a practical guide, and theoretical aspects are largely disregarded. Chemicals and equipment required as listed, and the reader is cautioned regarding possible sources of error. No information is given on sampling procedure or on the interpretation of results.--H. M. A. Rice.

2-909. Birch, Francis, and Paul LeComte. TEMPERATURE-PRESSURE PLANE FOR ALBITE COMPOSITION: Am. Jour. Sci., v. 258, no. 3, p. 209-217, 2 diags., 5 tables, March 1960, 13 refs.

The reaction, albite = jadeite + quartz, has been studied between 15 and 25 kilobars, 600 and 1,000°C. Two systems of generating pressure were used with mutually consistent results: a "simple squeezer," and a nitrogen system with hydrostatic pressure. The equilibrium line is given by the relation, $P = 6{,}000\ (\pm 500) + 20\ (\pm 2)\ T$, where P is in bars, T in degrees centigrade. This is in good agreement with the curve of Kelley and others based on thermochemical data; jadeite and quartz lie on the high-pressure side of the boundary.

The melting curve of albite has been followed to 15 kilobars; it may be represented by the relation, $T = 1{,}115 + 0.011P$. The rise of melting temperature with pressure is smaller than had been estimated from the difference of volume between crystal and glass at ordinary temperature.--Auth.

2-910. Foster, Perry A., Jr. DETERMINATION OF THE CRYOLITE-ALUMINA PHASE DIAGRAM BY QUENCHING METHODS: Am. Ceramic Soc., Jour., v. 43, no. 2, p. 66-68, 4 illus., diag., table, Feb. 1960, 8 refs.

The phase diagram of the system cryolite-alumina, from 0 to 18.5% alumina, was determined by quenching techniques. No compounds appeared, and no solid solubility was detected on either side of the eutectic. The eutectic point was established at 10.5 weight % alumina at 961°C.--Auth.

2-911. Honda, Masatake. COSMOGENIC POTASSIUM-40 IN IRON METEORITES: Geochim. et Cosmochim. Acta, v. 17, no. 1/2, p. 148-150, Aug. 1959, 11 refs.

Low level $\beta$ counting on K extracted from Fe meteorites confirmed the expectation that an excess of cosmogenic $K^{40}$ over natural $K^{40}$ should be present in Fe meteorites due to cosmic ray bombardment. The specific activity of K for 3 samples ranged from $.58 \pm .04$ to $.78 \pm .03$ counts/min. /mg., indicating an excess of $K^{40}$ compared with reagent K. The results were further corroborated by Wasserburg by means of mass spectrometric determination of the ratios of $K^{40}$ to $K^{39}$ and $K^{41}$ in the samples.--F. Manheim.

2-912. Pettersson, Hans. COSMIC SPHERULES AND METEORITIC DUST: Sci. American, v. 202, no. 2, p. 123-132, 5 illus., 3 graphs, Feb. 1960.

The author has been engaged in efforts to secure direct measurements of meteoritic fallout by collecting samples of meteoritic dust and cosmic spherules from the tops of mountains in remote areas and from ocean bottoms. The data show that meteoritic material falls to earth at the rate of about 5 million tons per year and that the rate of fall has varied during the past 10 to 15 million years. The spherule count varies from place to place on the ocean floor and from time to time in the geologic column. The cosmic spherules from the ocean floor indicate a relatively high rate of meteor fall in recent times. Divergence of the count in different parts of the ocean does not permit the computation of dependable averages. The discovery of spherules in cores of ocean-bottom sediments known to be several million years old refutes the theory that all meteorites are of recent origin. Collection of samples is continuing from stations in Hawaii and the Swiss Alps so that sufficient data may be obtained within the next few years to indicate the total amount of meteoritic dust actually falling to earth.--T. F. Rafter, Jr.

2-913. Cohen, A.J. MOLDAVITES AND SIMILAR TEKTITES FROM GEORGIA, U.S.A.: Geochim. et Cosmochim. Acta, v. 17, no. 1/2, p. 150-152, Aug. 1959, 10 refs.

Tektites from Georgia are briefly described and compared with similar occurrences from Texas, Bohemia, and Australia. Unpublished data on magnetic susceptibility and emission spectrographic analyses for Ag, Co, Cr, Li, Mn, Ni, Rb, Sr, Ti, V, and Zr are reported for a Georgia tektite and for 2 moldavites, a bediasite and an australite. In addition, published data, including density, index of refraction, absorption spectrum of the ferrous band, and absolute age, are summarized for the above specimens. The author concludes that the Georgia tektites show a close similarity to the Bohemian moldavites, and that tektite falls other than the Australian one may be widespread in distribution.--F. Manheim.

2-914. Barshad, Isaac. SIGNIFICANCE OF THE PRESENCE OF EXCHANGEABLE MAGNESIUM IONS IN ACIDIFIED CLAYS: Science, v. 131, no. 3405, p. 988-989, table, Apr. 1, 1960, approx. 15 refs.

Mg ions ($Mg^{++}$) were shown to constitute a substantial percentage of the total exchangeable cations in acidified clay samples from various sources. This finding helps in solving several problems of long standing in the fields of soil chemistry, soil formation, and geochemical weathering.--Auth.

2-915. Chave, Keith E. EVIDENCE ON HISTORY OF SEA WATER FROM CHEMISTRY OF DEEPER SUBSURFACE WATERS OF ANCIENT BASINS: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 3, pt. 1, p. 357-370, 8 diags., 7 tables, March 1960, 27 refs.

Subsurface waters of ancient basins are thought to be remnants of sea water entrapped with the sediments at the time of their deposition. The post-depositional alteration of these waters is investigated in order to evaluate the possibility of using their chemical composition as an indicator of ancient sea water chemistry.

A review of literature on subsurface water chemistry indicates that the reliability of the data is, in general, poor. Using the best analyses available, the concentrations of Cl, K, Ca, Mg, Sr, Br, and I in waters from rocks ranging in age from Pliocene to Ordovician are compared. There appear to be no significant compositional trends with time. The post-depositional processes altering the water chemistry are discussed. It is concluded that the magnitude of the modifying processes are so great that it is unlikely that evidence on ancient sea-water chemistry can be obtained from the study of subsurface waters.--Auth.

2-916. Pilkey, Orrin H., and John Hower. THE EFFECT OF ENVIRONMENT ON THE CONCENTRATION OF SKELETAL MAGNESIUM AND STRONTIUM IN DENDRASTER: Jour. Geology, v. 68, no. 2, p. 203-216, 5 diags., 7 tables, March 1960, 26 refs.

[illegible] Pacific Coast sand dollar, were collected from 24 localities between Vancouver Island, British Columbia, and Santa Rosalia Bay, Baja California. These [illegible] and the percentage of Ca calculated.

[illegible] content of Dendraster tests appears [illegible]. The percentage of $MgCO_3$ in tests from [illegible] salinity waters increases about 0.5% corresponding to an increase in mean summer water temperature of 11°C. A limited number of analyses of tests of other echinoid species indicates that the [illegible] in a linear manner with warmer water echinoid species of the same environmental type. Also, different echinoid species living under similar temperature conditions may deposit substantially different amounts of $MgCO_3$.

The Sr/Ca ratio in Dendraster tests is inversely related to water temperature and appears to be unaffected by changes in salinity.

With further work on recent forms it may be possible to determine paleotemperatures and salinities using the Mg and Sr content of unaltered fossils. [illegible]

2-917. Herzog, Leonard F., William H. Pinson, Jr., and Patrick M. Hurley. Rb-Sr ANALYSES AND AGE DETERMINATIONS OF CERTAIN LEPIDOLITES, INCLUDING AN INTERNATIONAL INTERLABORATORY COMPARISON SUITE: Am. Jour. Sci., v. 258, no. 3, p. 191-208, graph, 6 tables, March 1960, 21 refs.

Rb, Sr and radiogenic $^{87}SR$ concentrations, and radioactivity "ages" have been determined by stable isotope dilution for lepidolite samples from 8 pegmatite occurrences.

Five of the samples analyzed comprise an "intercomparison suite" ranging in age from 100 x $10^6$ to 2600 x $10^6$ years. Portions of these samples were sent by us to several other laboratories for analysis, as a test of the interlaboratory reproducibility of stable isotope dilution analysis. In this paper analytical data for this suite from 4 laboratories are compared. Interlaboratory reproducibility and intralaboratory reproducibility are essentially identical for the age determinations; it is apparent that age ratios for lepidolite can be measured routinely with analytical accuracy better than ± 4% (standard deviation).

Rb was determined with a precision of 1 to 2 %, and Sr with a precision of 1 to 3 % within individual laboratories; difference between results obtained at the several laboratories may be due in part to small differences in Rb and Sr standard solution calibrations and in part to sample inhomogeneities; the good interlaboratory agreement in age determinations favors the latter interpretation.

A comparison of stable isotope dilution, optical spectrographic, and neutron activation Rb/Sr data for sets of independently collected and analyzed samples from 6 localities is also given. For each pegmatite, there is good agreement (a range of a few percent) in the ages determined by isotope dilution and neutron activation, although Rb concentrations have ranges of up to 30%.

The study gives insight into the sources of error in the optical spectrographic technique and provides standards which may make possible the improvement of this method of analysis.--Auth.

## 8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Sedimentary Petrology 2-938, 2-939, 2-940; Mineral Deposits 2-972, 2-973, 2-974.

2-918. Lucas, Elmer L. SOME RELATIONS OF THE SHAPE OF QUARTZ SAND GRAINS TO THEIR CRYSTALLOGRAPHIC ORIENTATION: Oklahoma Acad. Sci., Proc., v. 39, 1958, p. 130-133, 2 illus., pub. 1959, 6 refs.

The shapes of many quartz grains, made round by abrasion, seem to reflect the outward expression of the original shape of the crystal or fragment. Many other grains tend to be longer and harder in the direction of the optic axis, which supports the idea of unequal wear. Both factors appear to be equally [illegible] in the ultimate rounding of quartz grains.--[illegible]

2-919. [illegible] DATA PERTAINING TO IMPORTANT NON-SILICATE MINERALS: Am. Geol. Inst., AGI Data Sheet 17, 2 p., in Geo-Times, v. 4, no. 6, p. 25-26, March 1960, 2 refs.

Presented in a compact form for insertion in a field notebook the following data is given on 115 of the more important nonsilicate minerals: crystal system or division, maximum hardness, specific gravity, and easily noted distinguishing features.--M. Russell.

2-920. Pommer, N.M. SYNTHESIS OF HÄGGITE: Geochim. et Cosmochim. Acta, v. 17, no. 1/2, p. 148, Aug. 1959, 2 refs.

A brief note reports that a hydrous tervalent-quadrivalent mixed vanadium oxide mineral synthesized and previously described by the author has been found in natural occurrence and named häggite by Evans and Mrose.--F. Manheim.

2-921. Mitchell, Richard S. SMALL BARITE NODULES FROM OVID, COLORADO: Rocks & Minerals, v. 35, no. 1/2, p. 9-11, 2 illus., diag., Jan.-Feb. 1960, 5 refs.

Brief but succinct geological and mineralogical description of occurrence of earthy barite nodules, some of which are geodal and contain euhedral, bright gemmy barite crystals of prevailing prismatic habit, elongated parallel to the a axis. Forms identified by goniometric measurement are described as well as variations in habits. Minerals associated with the barite are briefly described.--J. Sinkankas.

2-922. Huang, W.T. IDENTITY OF BASSANITE IN DRILL CORES IN COMANCHE COUNTY, OKLAHOMA: Texas Jour. Sci., v. 11, no. 3, p. 296-298, 2 illus., Sept. 1959, 3 refs.

The mineral bassanite is reported from drill cores taken at depths of 126 ft. and 180 ft. in an oil well 12 mi. SE. of Lawton, and another 27 mi. from the Wichita Mountains, both in Comanche County. The mineral occurs in layers less than 4 mm. thick. Chemical analysis shows CaO, 37.24%; $SO_3$, 54.55%; and $H_2O$, 7.21%. -- M. Russell.

2-923. Agrell, S.O., and Joseph V. Smith. CELL DIMENSIONS, SOLID SOLUTION, POLYMORPHISM, AND IDENTIFICATION OF MULLITE AND SILLIMANITE: Am. Ceramic Soc., Jour., v. 43, no. 2, p. 69-76, 7 figs. incl. illus., diags., 3 tables, Feb. 1960, approx. 23 refs.

X-ray, optical, and chemical data are presented for sillimanites and for a wide range of natural and synthetic mullites. Single-crystal X-ray studies have revealed a new type of mullite (called S mullite) characterized by subsidiary sharp reflections in distinction to the extra diffuse reflections of common mullite (called D mullite). Atomic substitution of Al in D mullite leads to expansion of a and c but not of b, whereas substitution of Fe and Ti in natural mullites gives a slight initial decrease in a and b followed by a subsequent increase; c increases uniformly for all concentrations. The data are consistent with solid solution ranging between the extremes $3Al_20_3 \cdot 2SiO_2$, $2Al_2O_3 \cdot SiO_2$, and $3(Al_{0.9}Fe_{0.1})_2O_3 \cdot 2SiO_2$. Cell dimensions of sillimanite vary only slightly. Consideration of the various methods of distinguishing mullite and sillimanite shows that the measurement of cell dimensions is the most reliable and for mullite has the added advantage that the S and D polymorphs may be distinguished and an estimate of the composition obtained for D mullite.--Auth

2-924. Ramsay, Alexander M. SCOTTISH GEMSTONE LOCATIONS: Lapidary Jour., v. 13, no. 4, p. 574, 576-582, map, Oct. 1959.

The body of the article consists of numerous gemstone localities arranged under species or varieties and compiled from Heddle's "The Mineralogy of Scotland" and McCaillen's "Gemstones of Scotland" plus localities personally examined by the author. The following species are covered: diamond, corundum (sapphire), topaz, garnet, zircon, prehnite, thomsonite, quartz, also freshwater pearls.--J. Sinkankas.

2-925. Jenni, Clarence M. NEW MINERALS FOR CALIFORNIA: Gems & Minerals, no. 268; p. 40, 95, Jan. 1960.

New mineral finds in California in 1959 are very briefly described. Recent field work by personnel of Harvard University resulted in identification of the following species new to the Crestmore Quarry at Riverside: plombierite, formerly called thaumasite; cristobalite; corundum; huntite; mimetite; pyromorphite; wulfenite; litharge. Howlite crystals and bakerite were found in Tick Canyon. Crystals of searlesite in vugs have been found at Boron; also tunnelite, smythite and berthierite.--J. Sinkankas.

2-926. Januzzi, Ronald Everett. THE MINERALS OF WESTERN CONNECTICUT AND SOUTHEASTERN NEW YORK STATE. COMPLETE WITH LOCALITY MAPS TO MAJOR MINERAL COLLECTING AREAS: 106 p., 17 maps, Danbury, Connecticut, Mineralogical Press, 1959.

A field guide which should be used in conjunction with standard textbooks on mineralogy. Nearly 200 minerals reported from the western Connecticut-southeastern New York State area are listed alphabetically in 3 lists. The first list gives the general chemical composition of each mineral, the second gives information about the localities where the mineral has been found, and the third covers the color, streak, and hardness of each mineral. Seventeen maps with direction information complete the booklet.--L. M. Dane.

2-927. Allaway, William H. INDIANA'S GEODES ARE MYSTERIOUS: Earth Sci., v. 13, no. 1, p. 19-20, 4 illus., Feb. 1960, 4 refs.

Peculiar, but definite shapes and patterns of geodes from beds in the vicinity of Bloomington, Indiana, suggest that the original voids filled by the geode materials resulted from the solution of fossil crinoids, brachiopods, corals, and other organic forms. --M. Russell.

## 9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Structural Geology 2-859; Stratigraphy 2-875; Geophysics 2-907.

2-928. Knox, Raymond G. THE LAND OF THE BURNT OUT FIRES, LAVA BEDS NATIONAL MONUMENT, CALIFORNIA. With Notes on Geology and Cave Life by Richard T. Gale: Natl. Speleol. Soc., Bull., v. 21, pt. 2, p. 55-66, 6 illus., 2 maps, July 1959, 12 refs.

Lava Beds National Monument encompasses part of the largest pseudokarst area in the United States. In its 46,238 acres are 293 lava tubes and caves. The tubes are up to 98 ft. in diameter, and up to a mile long; several are multilevel. Floors of the large tubes have uniform slope; many have a rough clinker floor. Access to the tubes is through collapse sinks. Seven major caves in the monument contain ice that lasts throughout the year. Pleistocene fossils as well as archeological material have been recovered from the caves. Historically the lava fields are known as the site of the Modoc Indian war 1872-1873 when the Indians made use of the pseudokarst features for strong defense emplacements.--Auth.

2-929. Rose, Robert L. TERTIARY VOLCANIC DOMES NEAR JACKSON, CALIFORNIA: California,

iv. Mines, Spec. Rept. 60, 21 p., 11-illus., 4 figs., tables, 1959.

Five separate volcanic domes occur near Jackson, alifornia, in an area overlain by a stratigraphic equence composed of 2 major units: an older or bed- ock series composed of Paleozoic and Mesozoic low- rade metamorphosed eugeosynclinal sedimentary nd volcanic rocks and a younger or superjacent eries of Eocene to Pliocene nonmarine sedimentary nd pyroclastic rocks. The older strata have been ghtly folded and intruded by a quartz diorite stock. he younger strata are tectonically undistributed. he domes of volcanic rock are associated with the ehrten formation, the youngest stratigraphic unit.

All of the domes are structurally similar and onsist of flow-banded felsophyre and breccia. The ow-banding in each dome is moderate to steep-dip- ing; near the margins it strikes parallel to the outer ontacts and dips inward, and in the center portions, e flow-banding is nearly vertical but variable in rike. The masses are evidently endogenous vol- anic domes that were emplaced as partly crystal- ne magna, too viscous to flow from vents.

Descriptions of individual domes are given with ock types ranging from hornblende dacite to rhyo- icite. The Jackson Butte dome differs from the her domes in that it contains xenoliths of metamor- ic and plutonic rocks including peridotite xenoliths ith prominent reaction rims.--C. W. Chesterman.

930. MacKenzie, David B. HIGH-TEMPERA- URE ALPINE-TYPE PERIDOTITE FROM VENE- UELA: Geol. Soc. America, Bull., v. 71, no. 3, 303-317, 4 illus., 2 fold. geol. maps, diags., ble, March 1960, 47 refs.

The Tinaquillo peridotite is the least serpentinized the ultramafic masses included in the N. 75E.- ending belt of Cretaceous metamorphic rocks in rthern Venezuela. It is a S.-dipping tabular mass intensely crushed and foliated dunite bounded on e N. by a S.-dipping regional thrust fault and on the by regionally metamorphosed hornblende-quartz- agioclase gneisses. Near the intrusion, these eisses have been contact-metamorphosed by the nite to garnet-augite-hornblende-andesine gneisses. rge tabular masses of gabbroic composition within e peridotite are interpreted as inclusions of con- ct-metamorphosed country rock. The peridotite ntains thin hornblende and pyroxene layers paral- l to the foliation and, in addition, remarkable lath- aped orthopyroxene phenocrysts flattened in the anes of foliation and oriented dimensionally and ystallographically parallel to one another. These hs were formed by the stretching-out of primary uant-shaped phenocrysts, probably during final-stage solid intrusion of the peridotite.

The structure and composition of the pyroxene and garnet minerals in the contact rocks indicate that the temperature of intrusion was between 800°C. and 1,000°C. During cooling, some of the thin pyroxene layers were altered hydrothermally to hornblende. Later and at still lower temperature, a belt of dunite along the Manrique thrust fault was altered to serpentinite and asbestos.

The other peridotites in the coastal range of northern Venezuela, which are moderately to intensely serpentinized, have no contact metamorphic aureoles, and some show conflicting age relationships toward the country rocks. Repeated upward movement during successive orogenies may explain these phenomena associated with serpentinites both in Venezuela and elsewhere.--Auth.

2-931. Walton, Matt. GRANITE PROBLEMS: Science, v. 131, no. 3401, p. 635-645, 4 illus., map, 6 diags., table, March 4, 1960, approx. 50 refs.

Beginning with a review of granite from the points of basic definition, historic recognition of structural relationships, the author carries "granite" thru the various theories of formation and the flaws in each. He then presents a new synthesis based on the work of O. F. Tuttle and N. L. Bowen and also that done by Yoder, Stewart, and Smith.

This synthesis is based on the "anatectic" model in which a body of rock, containing water, has a large inflow of heat due to crustal downbuckling or other orogenic process. The effect of water on silicate materials at very high pressures is tremendous, but it is yet to be found just how much movement can take place. Continued controlled experiments are a must so that exploration rather than hypothesis becomes the order of action.--C. W. Schreiber.

2-932. Denison, Rodger E. THE RHYOLITES OF OKLAHOMA: Oklahoma Acad. Sci., Proc., v. 39, 1958, p. 124-126, pub. 1959, 7 refs.

The rhyolites of Oklahoma represent a rather thick sequence of diverse rhyolite porphyries with minor interbedded tuffs and sediments. The recent reexamination of outcrop information and subsurface data from drill holes indicates they are of major significance.

Rhyolites crop out in the eastern Wichita Mountains and in the western portion of the Arbuckle Mountains. Though a relatively small outcrop component, the rhyolites dominate the subsurface basement complex between the 2 mountain trends. Westward these rocks appear to correlate with similar rhyolites in the basement rocks of the Texas panhandle.--Auth.

## 10. SEDIMENTARY PETROLOGY

e also: Areal and Regional Geology 2-834; Geomor- ology 2-848.

933. Nelson, Bruce W. THE RECENT SEDI- NT RESEARCH PROGRAM AT V.P.I.: Mineral ustries Jour., v. 6, no. 3, p. 1, 4, illus., Sept. 59.

During the last 3 years the Dept. of Geological ences at Virginia Polytechnic Institute has organ- d a research program in the field of recent sedi- ntation as a part of its instructional and research activities. It has 5 major objectives: the study of 1) weathering processes, 2) stream transportation, 3) ground and surface water quality 4) estuarine and nearshore circulation systems and the transportation and deposition of sediments in such systems, and 5) changes that take place in sediments after their deposition. The site of the study is the E. coast of Virginia in the drainage basins of the Rappahannock and York rivers. Special facilities for the program include permanent laboratories in Blacksburg and a specially equipped trailer laboratory for field work. --M. Russell.

2-934. Prentice, J.E. FLOW STRUCTURES IN SEDIMENTARY ROCKS: Jour. Geology, v. 68, no. 2, p. 217-225, illus., 3 secs., 4 diags., table, March 1960, 13 refs.

A number of oriented sedimentary structures from graywacke sequences in N. Lancashire and Devonshire, England, are described and their origin discussed. It is concluded that they originated by horizontal flow of sediment, induced either by the drag of the depositing current or by sliding down a slope. In the Lancashire examples these "flow casts" indicate a direction of movement corresponding to that shown by the associated flute casts and groove casts. In the Devonshire examples these directions do not coincide, and it is suggested that this may be due to the eroding current flowing transversely across a sea-bed slope, which subsequently controls the direction of the depositing flow.--Auth.

2-935. Hardy, Robert M., and Robert F. Legget. BOULDER IN VARVED CLAY AT STEEP ROCK LAKE, ONTARIO, CANADA: Geol. Soc. America, Bull., v. 71, no. 1, p. 93-94, illus., Jan. 1960, 6 refs.

Unwatering of Steep Rock Lake in western Ontario has allowed study of varved sediments heretofore covered by water. A small boulder was found in the varves near the center of Falls Bay in the NE. corner of the lake. The freshly dredged clay surfaces are treacherous, and it was not possible to recover the boulder for study; it was however, about 8 in. in diameter and partially rounded. It is assumed that the boulder was dropped from floating ice and fell through some 450 ft. of water before coming to rest on the clays of the lake bed. A photograph of the boulder shows that the lake sediments must have had considerable shearing strength at the time the boulder was deposited. The boulder pierced only 2 thin laminations and was held by the third thin layer. It follows that the gain in shear strength must have been much more rapid for those recently deposited sediments than for normally deposited soils. The sediment was compressed for several inches below the boulder, and subsequent consolidation of these same layers due to the addition of 100 ft. of overburden was not so great as that produced locally by the weight of the small boulder. Therefore, the sediment must have increased in particle bond strength, thereby reducing compressibility, during the interval between deposition of the boulder and accumulation of the remaining sediment. Such a rapid build up of thixotropic forces between sediment particles could be used to explain other reported phenomena in Steep Rock soils.--B. W. Pipkin.

2-936. Bramlette, M.N., J.L. Faughn, and Robert J. Hurley. ANOMALOUS SEDIMENT DEPOSITION ON THE FLANK OF ENIWETOK ATOLL: Geol. Soc. America, Bull., v. 70, no. 12, pt. 1, p. 1549-1551, map, Dec. 1959, 2 refs.

Of 11 short cores taken on the SW. flank of Eniwetok Atoll, Marshall Islands, 6 penetrated Pliocene fine-grained pelagic sediments strikingly different from the Quaternary mantle. The presence of coccoliths, including discoasters, in the foraminiferal Pliocene deposits imply less water agitation than under present conditions.--M. Russell.

2-937. Hubert, John F. SYNGENETIC BLEACHED BORDERS ON DETRITAL RED BEDS OF THE FOUNTAIN FORMATION, FRONT RANGE, COLORADO: Geol. Soc. America, Bull., v. 71, no. 1, p. 95-98, 2 illus., diag., table, Jan. 1960, 6 refs.

The Permo-Pennsylvanian Fountain formation (excluding the basal Glen Eyrie shale member) is a well known continental deposit in the western United States. The formation is mainly red arkose (channel deposits) and redstones (flood-plain sediments). The formation is predominantly red colored except for syngenetic bleached white borders on cross-laminated channel arkoses. The white borders are between 6 in. and 2 ft. thick and occur at the contacts of arkose beds with redstone layers. Cross-laminations cross the white border-red bed contact, indicating bleaching of the red beds rather than nonhematite-stained sand deposition. As the white borders form an envelope around red arkose beds, they are clearly not the result of epigenetic reduction of Fe in these beds.

The amount of Fe in the bleached borders, redstones, and red arkoses was determined by X-ray fluorescence in order to learn 1) whether there had been simple reduction of ferrous Fe in the bleached parts, or 2) if ferrous Fe had been removed and precipitated as ferric Fe or carried away in solution. Analysis of 17 samples reveals that the elemental Fe content of the bleached borders is consistently lower than the red beds, indicating removal of Fe from the borders. It is suggested that ferric Fe in the channel arkoses was reduced to ferrous Fe by hydrogen sulfide and dissolved in carbonate waters entrapped in the channel sands. The ferrous Fe was then precipitated as ferric Fe in the less permeable flood-plain sediments.--B. W. Pipkin.

2-938. Hutton, C. Osborne. MINERALOGY OF BEACH SANDS BETWEEN HALFMOON AND MONTEREY BAYS, CALIFORNIA: California, Div. Mines, Spec. Rept. 59, 32 p. 5 figs., 13 tables, 1959.

A study has been made of the nature of the heavy mineral assemblages in beach sands on a strip of the California coast from the N. end of Halfmoon Bay to Pacific Grove at the S. end of Monterey Bay.

The methods used in fractionation of heavy minerals from crude sands included elutriation, flotation in heavy liquids, electromagnetic and centrifuge separation, and hand-picking. Electromagnetic work has provided a considerable amount of data on the magnetic susceptibility of a number of minerals of known composition.

In all, 35 minerals or mineral groups have been recognized by determination of physical properties and/or chemical composition. Complete chemical analyses of biotite, monazite, and thorite have been made and discussed in relation to their structural formulae and physical properties. From the Pb/Th, U ratios in monazite clearly derived from the granitic rocks at Monterey, an age of 106 x $10^6$ years has been determined.

Recognition of the nature of the nontranslucent mineral particles was aided by inspection in oblique illumination with a wide field binocular microscope and by magnetic fractionation. Other methods of identification included: chromatographic techniques, use of alpha-ray track plates, and the $NaF$-$Na_2O_3$ fusion mixture for detection of U-bearing minerals.

With the exception of a few rare minerals of unknown source, the heavy minerals in the beach sands have been derived from rocks that make up the drainage area of the streams that reach the Pacific Ocean in the area under study.--M. C. Stinson.

2-939. Smoot, Thomas W. CLAY MINERALOGY OF PRE-PENNSYLVANIAN SANDSTONES AND SHALES OF THE ILLINOIS BASIN. PART I. RELATION OF PERMEABILITY TO CLAY MINERAL SUITES: Illinois State Geol. Survey, Circ. 286, 20 p., 8 figs. incl. map, 3 diags., 5 tables, 1960, 11 refs.

The clay mineral compositions of approximately 110 samples of pre-Pennsylvanian sandstones, argillaceous sandstones, and shales of the Illinois basin have been investigated by X-ray diffractometry. Eighty percent of them are from Mississippian Chester sediments; the remainder are from the Mississippian Valmeyer series and the Ordovician and Cambrian systems. Ninety-five percent of the samples are from cores and the others are from outcrops.

Clay minerals from the permeable sandstones are characterized by a heterogeneous mixture of degraded illites and chlorites, kaolinite, and minor amounts of montmorillonite (if present). Those from the shales are characterized by well crystallized illite and chlorite, minor amounts of degraded illite and chlorite, and, rarely, trace amounts of kaolinite.

The differences are apparent in intimately associated sediments that came from the same general source area, and had approximately the same environments of deposition and the same originally introduced clay mineral suites. Therefore, it is concluded that the heterogeneity in the sandstone clay mineral suites has been brought about by degradation (after lithification) by circulating formation fluids, the composition of which has varied from time to time. The low permeabilities of the shales have prevented such circulation from taking place so that their clay minerals have been protected from degradation.--Auth.

2-940. Smoot, Thomas W., and Kedar Narain. CLAY MINERALOGY OF PRE-PENNSYLVANIAN SANDSTONES AND SHALES OF THE ILLINOIS BASIN. PART II. CLAY MINERAL VARIATIONS BETWEEN OIL-BEARING AND NON-OIL-BEARING SANDSTONES: Illinois State Geol. Survey, Circ. 287, 14 p., 2 maps, 2 graphs, 2 tables, 1960, 7 refs.

The clay mineral compositions of approximately 70 samples of oil-bearing and non-oil-bearing sandstones from the Mississippian Chester series of the Illinois basin were determined. Part of the samples are from 9 Chester formations located throughout the deep part of the basin; the others are from the Aux Vases formation in a limited area in Hamilton County.

Easily discernible differences between the compositions of clay minerals from oil-bearing and non-oil-bearing sandstones, apparent in both randomly chosen samples and closely associated samples, are thought to be partly a function of the presence or absence of hydrocarbons. Studies of these differences may be of use in the investigation of the time and mode of oil accumulation.--Auth.

2-941. Cooper, Byron N. COMMENTS ON ANOTHER VIRGINIA "LIMESTONE": Mineral Industries Jour., v. 6, no. 3, p. 3-4, illus., Sept. 1959.

The many extremely fine petrographic features to be seen in a specific sample of a millimeter-banded Ca-Mg carbonate rock from the Ordovician Beekmantown formation near Alma, Page County, Virginia, reveal information on conditions of sedimentation and diagenesis that is rarely obtained by "big-picture" petrographic descriptions now in vogue. A greater attention to fine details will give results well worth the extra effort.--M. Russell.

2-942. Wiggins, J.W. SAMPLE STUDY AND CORRELATION OF E.C. KESSELRING NO. 1 WELL: New York State Mus. & Sci. Service, Geol. Survey, [unnumbered publication], 49 p., [1960?].

A microscopic sample study of well cuttings from the surface to a total depth of 11,145 ft. The well, located in Van Etten Township, Chemung County, New York, starts in the Senecan series of the Upper Devonian and ends in the Croixian series of the Upper Cambrian.--W. L. Kreidler.

## 11. GEOHYDROLOGY

See also: Geologic Maps 2-810, 2-811, 2-813, 2-814; Geophysics 2-900.

2-943. Haas, John L., Jr. EVALUATION OF GROUND WATER TRACING METHODS USED IN SPELEOLOGY: Natl. Speleol. Soc., Bull., v. 21, pt. 2, p. 67-76, 2 diags., 2 graphs, 2 tables, July 1959, 16 refs.

Inorganic chemicals, dyes, bacteria, and radioactive elements were found to have been used to determine speed and path of flow of ground water in limestone.

Considering the peculiarities of water flow through limestone and the equipment available to the average speleologist, the following methods of stream tracing are recommended:

1) If it is necessary to know only if 2 streams in a limestone area are connected, the Dunn method is recommended. This method employs the detection of fluorescein in the stream by use of adsorbent coconut charcoal. The dye is then leached from the charcoal by an ethyl alcohol solution containing 5% potassium hydroxide.

2) If it is necessary to know also the speed of flow, a variation of Slichter's method is recommended. This method employs the detection of ions in the water by the increase in electrical conductivity as the ions pass the site of suspected emergence. Slichter recommends ammonium chloride be used as the tracer.--Auth.

2-944. Howe, Robert H. L. THE APPLICATION OF AERIAL PHOTOGRAPHIC INTERPRETATION TO THE INVESTIGATION OF HYDROLOGIC PROBLEMS: Photogramm. Eng., v. 26, no. 1, p. 85-95, 7 illus., 2 maps, 2 charts, 2 diags., graph, 2 tables, March 1960, 4 refs.

This paper discusses the application of aerial photographic interpretation to various hydrologic problems. Aerial photographic interpretation has been found to be useful in the investigation of surface-water problems, including: 1) the preparation of drainage maps, 2) the study of surface drainage patterns, 3) the evaluation of a watershed, 4) the study of a stream channel condition in relation to geology, and 5) the preparation of a hydrologic model. Aerial photographic interpretation also has been applied to the investigation of ground-water conditions, including: 1) the identification and location of water-bearing formations, 2) the aerial photographic patterns of water-bearing formations, 3) the evaluation of ground-water potentials, 4) the evaluation of ground-water inventories and the preparation of a regional ground-water map, and 5) the prediction of the ground-water quality of an area.--Auth.

2-945. Brent, William B. **NOTES ON RECENT OBSERVATION OF TIDE SPRING, NEAR BROADWAY, VIRGINIA: Oklahoma Acad. Sci., Proc., v. 39, 1958, p. 119-120, pub. 1959, 2 refs.**

The cycle of Tide spring, near Broadway, Virginia was observed over a 2-day period in Sept. 1958. The complete cycle averaged 1 hour, rate of flow at maximum was several hundred gallons per minute. Rate of decline is greatest just after maximum inflow is reached and continues until only about 8 in. of water remain in the basin. An underground pool and siphon system is considered the cause of irregular flow.--M. Russell.

2-946. Norris, Stanley E. **VERTICAL LEAKAGE THROUGH TILL AS A SOURCE OF RECHARGE TO A BURIED-VALLEY AQUIFER AT DAYTON, OHIO: Ohio, Div. Water, Tech. Rept. no. 2, 16 p., 2 maps, sec., 4 graphs, table, 1959, 7 refs.**

The rate of leakage through a bed of glacial till, which separates 2 sand and gravel aquifers in a buried valley, was calculated from a pumping test run in 1953, before pumping from the lower aquifer became appreciable. The median value (0.003 g.p.d./ft.$^3$ ) of the leakage coefficient ($\frac{p'}{m'}$) is checked 1) by relating it to the quantity of water subsequently pumped from the well field, the estimated areal extent of the cone of depression, and the difference in water levels between the upper and lower aquifers, and 2) by computing the drawdown at a point where water-level data are available and comparing the computed value with the observed drawdown.--Auth.

2-947. Richter, Raymond C., and Robert Y.D. Chun. **ARTIFICIAL RECHARGE OF GROUND WATER RESERVOIRS IN CALIFORNIA: Am. Soc. Civil Engineers, Irrigation & Drainage Div., Jour., v. 85, no. IR4, pt. 1, p. 1-25, table, Dec. 1959, 75 refs.**

This paper discusses some of the present needs for practice of artificial recharging of ground water, describes the major types of artificial recharge projects used, summarizes the extent of artificial recharge activities, and reviews some of the important factors related to selection of artificial recharge project sites with particular emphasis on infiltration rates.--Auth.

2-948. Thomas, Robert O. **LEGAL ASPECTS OF GROUND WATER UTILIZATION: Am. Soc. Civil Engineers, Irrigation & Drainage Div., Jour., v. 85, no. IR4, pt. 1, p. 41-63, Dec. 1959, 13 refs.**

This paper discusses the historical basis of water rights doctrines, their application to rights to the use of ground water, general considerations affecting the regulation of rights, various aspects of ground water utilization, including problems of recharge and water demand, and concludes with a presentation of some of the possible legal problem areas which may arise in planning and administering future ground-water operations.--Auth.

2-949. U.S. Geological Survey. **GROUND-WATER LEVELS IN THE UNITED STATES, 1956. NORTH-CENTRAL STATES: Its: Water-Supply Paper 1456, 76 p., 10 maps, tables, 1959, refs.**

Separate reports cover Illinois, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin. Water levels are reported alphabetically by county for each state, and maps show the location of observation wells included in each report.--A. C. Sangree.

2-950. California, Dept. of Water Resources. **GROUND WATER CONDITIONS IN CENTRAL AND NORTHERN CALIFORNIA 1957-58: Its: Bull. no. 77-58, [406] p., 9 fold. pls. incl. 2 maps, profile, graphs, 5 tables, Oct. 1959, approx. 40 refs.**

Ground-water levels in the spring of 1958 generally were moderately higher than they were in the spring of 1957 in the N. Coastal, San Francisco Bay, and central Coastal regions. Notable exceptions were declines in water levels locally in areas of overdraft in Petaluma Valley, in the bayward segments of Napa and Sonoma valleys, in Suisun-Fairfield Valley, in the Hollister area, and in S. Alameda County, Pajaro Valley, and Salinas Valley where water levels in substantial parts of the ground-water basins have remained below sea level, allowing continued intrusion of sea water.

Substantially higher water levels in parts of the ground-water basins in the Santa Clara Valley in Santa Clara County, and elimination of a downward trend of water levels in other parts, attest to the effectiveness of artificial recharge operations being carried out by the local water conservation districts.

In the Sacramento Valley, average ground-water levels were somewhat higher, or little different from, the levels of 1957. However, long-term records of wells in several areas indicate that slightly or even substantially higher levels in 1958 represent a temporary interruption only of the downward trend in water levels that has prevailed for many years in Glenn, Yuba, Placer, Sacramento, Yolo, and Solano counties. In local areas of overdraft in Placer and Sacramento counties, lower levels in 1958 very definitely continued the downward trend.

In the San Joaquin Valley, significantly higher levels in 1958 were found principally in the ground-water units that receive surface water from the Friant-Kern Canal. Long-term hydrographs for selected wells in these ground-water units show a marked downward trend in water levels over the years prior to 1951, the first year of substantial deliveries from Friant-Kern Canal. Subsequent to 1951 and through 1958 an upward trend is shown, especially where artificial ground-water recharge has been carried out in addition to the substitution of imported surface water for pumped ground water. Significantly lower levels in 1958 occurred in an area of overdraft in the Calaveras unit of San Joaquin County and generally throughout the greatly overdrawn basins in the southern and southwestern parts of the valley. Hydrographs for selected wells in the latter areas show that the drop in levels from 1957 to 1958 was but a continuation, if not an acceleration, of the downward march of water levels that has prevailed for the past 10 to 20 years.--H. O. Banks.

2-951. California, Dept. of Water Resources. **SAN DIEGUITO RIVER INVESTIGATION: Its: Bull.**

o. 72, 2 v., 25 pls. incl. maps, profiles, secs., raphs, 90 tables, Nov. 1959, approx. 50 refs.

The San Dieguito River, located in the central ortion of San Diego County and draining into the Pa- ific Ocean, has been regulated, and its water uti- zed, to a limited extent. It is expected that local ater resources will be developed more extensively ome time in the future and put to beneficial use. The eed for effective long-range planning prompted a omprehensive investigation of this river. The in- roductory chapter covers the authorization for inves- gation, related investigations and reports, and the cope of investigation and report.

The procedures followed in the investigation and e resulting proposed plans and accomplishments re presented in the 6 following chapters. Chap. 2 resents data on recorded and estimated precipitation, unoff, and the water imports to and exports from the rea. A discussion of ground-water hydrology, the uality of surface and ground waters, and estimates f safe yields of presently developed water supplies re also given in this chapter. Chap. 3 describes e past, present, and probable ultimate land use. he unit values of consumptive use of water and resent and probable ultimate water requirements ithin the watershed, and of the city of San Diego, re also given, as are present and probable ultimate upplemental water requirements. Chap. 4 presents lans for development of surface and ground water upplies and describes the facilities required to nplement the plans. Chap. 5 discusses flood con- rol accomplishments from operation of large con- ervation reservoirs. Chap. 6 compares the cost nd yields of the various plans discussed in Chap. 4. hap. 7 contains conclusions resulting from the in- estigation and presents recommendations.

Appendixes to this report, found in v. 2, contain e agreement authorizing the investigation, a de- cription of the geology of the watershed (separately bstracted below), previously unpublished precipitation nd evaporation records, information on recorded and stimated runoff, water quality mineral analyses, a st of applications to appropriate water, estimates f land use, land classification, consumptive use of ater, records and estimates of water import and ex- ort, results of exploratory drilling and of laboratory ests of soil samples from potential borrow areas and am sites under investigation, detailed cost estimates f project works discussed in the report, and results f reservoir operation studies for facilities located, r the most part, outside the watershed.--From trod.

-952. California, Dept. of Water Resources. **EOLOGY AND GROUND WATER OF SAN DIEGUITO IVER WATERSHED** (In its: San Dieguito River In- estigation: Bull. 72, v. 2, Appendix B, p. B1-B54, ates (in v. 1), 5 tables, 1959) 36 refs.

During the late Pleistocene, an ancestral San Die- uito River in San Diego County, California, en- enched a channel into the coastal segment of the La lla formation of Eocene age to a depth of approxi- ately 200 ft. below present sea level. This en- renched channel was backfilled with approximately 00 ft. of alluvium as sea level gradually rose to its resent level. Alluvial deposits in the old channel onsist of sand, gravel, silt and clay and are mod- rate to high in permeability (1780 to 2800 gallons er day per square foot) as determined by well pump- g tests. Unconsolidated alluvium in the old channel pparently extends out to an unknown distance on the acific Coast continental shelf. Before extensive development of the ground water basin occurred, when a seaward hydraulic gradient existed, subsurface outflow took place through the buried mouth of the San Dieguito River. During the current period of overdraft, ground-water levels and current water quality data indicate that some subsurface inflow of poor water quality enters the alluvium-filled portion of the San Dieguito River basin from the seaward extension of the old San Dieguito River buried channel. --R. C. Richter.

2-953. California, Dept. of Water Resources. **SANTA ANA RIVER INVESTIGATION**: Its: Bull. no. 15, 207 p., 21 illus., 17 maps (14 col.), profile, secs., 3 graphs, 56 tables, Feb. 1959, approx. 75 refs.

The Santa Ana River basin lies on the Pacific slope of southern California and includes parts of San Bernardino, Riverside, Orange, and Los Angeles counties. An introductory chapter deals with the scope of the investigation and with the topography, stream systems, climate, native cover, soils, geology, and present development of the area under investigation.

Results of the Santa Ana River Investigation are presented in Chaps. 2-6. Chap. 2 contains evaluations of precipitation and surface and subsurface inflow and outflow. It also includes results of investigation and study of the ground-water resources, and contains data regarding mineral quality of surface and ground waters. Chap. 3 includes data and estimates of land use and water utilization under 1948 conditions and under probable ultimate conditions of development, and contains corresponding estimates of supplemental water requirements. Chap. 4 describes preliminary plans for conservation of available local water supplies to meet supplemental water requirements in part and discusses possible plans for importation of additional water supplies to meet the remainder of 1948 and probable ultimate supplemental water requirements. Chap. 5 presents a discussion of flood problems and possible remedial measures. Chap. 6 includes conclusions and recommendations resulting from the investigations and studies.

Appendices contain reports on related investigations, the geology of the San Jacinto and Elsinore units, monthly precipitation and stream runoff records, data on imports and exports of water and sewage, records on depth to ground water, land use, and information on flood control projects.--From introd.

The present basic water problem in the Santa Ana River basin consists of a perennial overdraft on ground water resources throughout most of the basin, indicating a need for importation of supplemental water supplies. Although this situation did not apply in the Bunker Hill and Riverside subunits of the Upper Santa Ana unit under 1948 conditions, it will exist in all subdivisions of the basin under ultimate conditions of development.

The mean seasonal requirement for supplemental water in the Santa Ana River basin under 1948 conditions, excluding supplies imported from the Colorado River, was about 66,400 acre-ft., distributed as follows: upper Santa Ana unit, 23,500 acre-ft.; San Jacinto unit, 12,000 acre-ft.; Elsinore unit, 5,100 acre-ft.; and lower Santa Ana unit, 25,800 acre-ft.

In 1951-1952, water was imported to the Santa Ana River basin from the Colorado River for direct use in the amount of 16,040 acre-ft. distributed as follows: upper Santa Ana unit, 220 acre-ft., San Jacinto unit, 860 acre-ft.; and lower Santa Ana unit, 14,960 acre-ft. An additional 38,150 acre-ft. of untreated water was imported and spread in the lower Santa Ana unit.

Under probable ultimate conditions of development in the Santa Ana River basin, the mean seasonal requirement for supplemental water will be about 705,000 acre-ft., distributed as follows: upper Santa Ana unit, 339,000 acre-ft.; San Jacinto unit, 138,000 acre-ft.; Elsinore unit, 12,000 acre-ft.; and lower Santa Ana unit, 216,000 acre-ft.

Limited amounts of supplemental water are susceptible of development locally in the Santa Ana river basin through possible operation of Prado Flood Control basin to reduce present waste of water to the ocean, through reduction of nonbeneficial consumptive use by phreatophytes in high water table areas, and through possible reclamation of sewage. However, within the limits of practicable development of these sources, it is probable that not more than 27,000 acre-ft. per season could be salvaged, which quantity would be sufficient to meet only a portion of the supplemental water requirement under 1948 conditions.

Satisfaction of the probable ultimate requirement for supplemental water in the Santa Ana River basin will require importation of some 678,000 acre-ft. per season, over and above that amount which could be developed locally. This greatly exceeds the probable maximum entitlement of member agencies of The Metropolitan Water District of Southern California within the basin to water from the Colorado River under presently claimed rights of that district.

An additional water problem in the Santa Ana River basin is manifested in local degradation of the normally good to excellent quality ground waters by: 1) Intrusion of sea water and oil field brines into the confined fresh-water aquifers of the Santa Ana pressure area, resulting from depressed ground-water elevations brought about by overdraft conditions; 2) induced flow of poor quality ground water from beneath Lake Elsinore to surrounding fresh ground-water bodies, from the same cause as in 1) above; 3) natural emanations from fault zones; and 4) unfavorable salt balance in the Riverside subunit of the upper Santa Ana unit and in the Santa Ana Forebay. Such degradation is also potential under present conditions in the San Jacinto and Elsinore units and may be a problem in other areas in the future.

Elimination of problems arising from unfavorable salt balance will require increasing outflow of ground water from the unit or subunit concerned and importation of water in an amount equal to the resulting increase in supplemental water requirement. To minimize importation of supplemental water for maintenance of salt balance it would be desirable to utilize an available supplemental water supply of the best possible quality.

The remaining important water problem in the Santa Ana River basin is damage to lands and improvements adjacent to the channels of many of the streams in the basin by reason of periodic uncontrolled flood flows.--From concl.

2-954. California, Dept. of Water Resources, Division of Resources Planning. Its: **REPORT ON PROPOSED WHEELER RIDGE-MARICOPA WATER STORAGE DISTRICT, KERN COUNTY:** 87 p., 3 fold. maps, 34 tables, July 1959.

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- A. Mineral Analyses of Surface, Ground and Waste Water
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- C. Computations of Payment Capacity for Water

2-955. Mack, Seymour. **GEOLOGY AND GROUND-WATER FEATURES OF SHASTA VALLEY, SISKIYOU COUNTY, CALIFORNIA:** U.S. Geol. Survey, Water-Supply Paper 1484, 115 p., 4 illus., 3 maps (2 in pocket, scale 1:62,500), 3 secs., 6 graphs, 23 tables, 1960, 35 refs.

Shasta Valley is in the central part of Siskiyou County, and about 12 mi. S. of the Oregon border. It lies between the Klamath Mountains on the W. and the Cascade Range on the E. The valley has an area of about 250 sq. mi.; the N.-S. length is about 30 mi., and the maximum width is about 15 mi. The average precipitation from July 1 to June 30 at Yreka and Montague is about 17 and 12 in. respectively, and the average annual temperature at Yreka is 51.5°F. The area has a population of about 12,000, most of whom are employed in farming, cattle raising, and lumbering. The farm income is derived chiefly from livestock, principally beef cattle, hogs, and sheep. Alfalfa, wheat, barley, oats, and rye are the main crops grown in the valley.

The Klamath Mountains are underlain by metamorphic and sedimentary rocks of Paleozoic age and by intrusive rocks of Mesozoic age that form the basement complex. Near Yreka the Chico formation of Late Cretaceous age, which is composed of shale, sandstone, and some conglomerate, overlies the older rocks with profound unconformity. The Chico formation in turn is overlain disconformably by the Umpqua formation of Eocene age, which consists mainly of black shale. These rocks are covered by a thin veneer of older alluvium which floors much of the northern part of the valley.

Volcanic rocks make up much of the valley floor from Montague southward to Edgewood. The southeastern, flatter part of the valley is occupied by the Plutos Cave basalt, which is a relatively large single flow erupted from the NE. flank of Mount Shasta within the last few thousand years. The western half of the valley floor is occupied largely by the older volcanic rocks of the western Cascades, which range in age from Eocene to Miocene and which have been eroded into hillocks that range in height from a few feet to as much as 300 ft. Between these hillocks lie many small ponds and marshes and the alluvial flats formed by slow, winding streams.

The valley is drained principally by the Shasta River and Parks Creek, which rise in the Klamath Mountains, and the Little Shasta River, which rises in the high Cascades. The volcanic rocks of the high Cascades were built by eruptions that commenced at the close of the Miocene epoch and continued intermittently to Recent time. Mount Shasta was built mainly during the Pleistocene epoch.

Morainal and fluvioglacial deposits, which are concentrated at the S. end of the valley, were formed mainly during Pleistocene time by glaciers that descended the NW. flanks of Mount Shasta. Glaciers still remain on Mount Shasta and have supplied fluvioglacial debris to the valley during Recent time.

The Plutos Cave basalt constitutes the principal aquifer in the valley, yielding abundant water for irrigation, stock, and domestic wells in the vicinity of Big Springs. Yields of irrigation wells in the basalt average about 1,300 g.p.m. (gallons per minute). The andesitic lavas of the western Cascades supply sufficient water for domestic and stock uses. Yields of wells tapping the andesites vary greatly because of rapid changes in lateral and vertical permeability. Abundant water for irrigation is yielded from fractures in the volcanic rocks of the western Cascades in the Gazelle-Grenada area.

The basement complex and the Chico and Umpqua formations are tapped by relatively few wells in the area, although locally these wells seem to yield sufficient water for domestic and stock uses. The basement complex yields water from joints, faults, shear zones, and openings along foliation planes.

The morainal and fluvioglacial deposits generally yield sufficient water for domestic and stock uses. Several irrigation wells tapping glacial materials E. of Edgewood yield 600 to 1,500 g.p.m. The younger and older alluviums of Recent and Pleistocene age yield water sufficient for domestic and stock uses. Along the W. side of the valley the younger alluvium yields sufficient water for irrigation and supplies Yreka with abundant water for municipal uses.

Ground water moves generally northward in the southern part of Shasta Valley and troughward from the E. and W., converging toward the Shasta River along the valley axis. At the N. end of the valley an eastward-trending divide separates the ground water that moves N. to Willow Creek from ground water that moves S. to the Shasta River.

Recharge to ground water is effected by deep infiltration of precipitation that falls on the tributary drainage area, principally the western slopes of Mount Shasta, and by seepage from streams. The mean annual precipitation on the valley floor of 12-15 in. probably is not sufffficient to contribute much recharge to ground water, but during years of above-average precipitation some deep penetration probably occurs. Recharge from irrigation water in 1953 was about 15,000 acre-ft. from a total surface-water diversion of 58,000 acre-ft., and recharge from ground water pumped for irrigation was about 2,000 acre-ft.

Ground-water discharge in Shasta Valley occurs principally by seepage into streams, which is estimated crudely to have been 70,000 acre-ft. in 1953. Big Springs has an annual discharge of about 30,000 acre-ft. Evapotranspiration from subirrigated crops is estimated to have been 28,000 acre-ft. in 1953. Pumpage for all uses in 1953 was approximately 6,000 acre-ft., and net draft was about 4,000 acre-ft. Ground-water discharge in 1953 by all these principal means was about 130,000 acre-ft. In addition, there was minor discharge from flowing wells, unestimated discharge from small springs on the valley floor, and evapotranspiration losses from relatively small areas of phreatophytes.

Because of the relatively small pumpage in the valley, water levels in wells show declines of only 5-10 ft. during the summer and autumn. So far as is known, the levels each winter and spring recover nearly completely, and as of 1953 there had been no indication of a long-term decline of water levels in the valley.

Surface water and ground water are generally low in dissolved mineral content and with few exceptions meet minimum standards for irrigation and domestic use. A close correlation exists between the composition of the various rock types in the area and the mineralization of surface and ground waters in areas adjacent to each rock type.--Auth.

2-956. Fishel, V.C., E.L. Gulley, and E.L. Reavis. **GROUND-WATER LEVELS IN OBSERVATION WELLS IN KANSAS, 1958: Kansas, State Geol. Survey, Bull. 141, 146 p., 16 maps, 12 graphs, 4 tables, 1959, 4 refs.**

Measurements of water levels in 717 wells in 71 counties in Kansas in 1958 are given in this report, which is the third in a series of annual water-level reports to be published by the state. Records for part of the wells for years prior to 1956 have been published in an annual series of water-supply papers by the U. S. Geological Survey; records for some of the wells that are in the Missouri basin have been issued in an annual series of mimeographed reports for the years 1947 through 1955, and records for some wells have been included in both reports.

Annual precipitation ranged from 51.90 in. at Atchison in eastern Kansas to 15.99 in. at Goodland in western Kansas. Most of the state received above normal precipitation for the year, but precipitation was below normal in a few local areas.

Owing to the above-normal precipitation during 1958, the ground-water levels in most wells in Kansas rose during the year. The average rise of water level in 4 key wells in central Kansas was about 1.9 ft. The rise of the water level in a key well in eastern Kansas was about 2.9 ft. The water level in many wells had recovered to the predrought stage. During the drought years 1952 through 1956, most ground-water levels in Kansas were at record low stages.--Auth.

2-957. Turcan, Alcee N., Jr., and Stuart W. Fader. SUMMARY OF GROUND-WATER CONDITIONS IN SOUTHWESTERN LOUISIANA, 1957 AND 1958, WITH A DISCUSSION OF IRON IN WATER FROM THE CHICOT AQUIFER: Louisiana, Geol. Survey, Water Resources Pamph. no. 6, 27 p., 4 maps (3 fold.), 4 graphs, log, 4 tables, June 1959, 8 refs.

During the period 1946-1957, an average of 560 million gallons of water was pumped daily from wells in southwestern Louisiana. This withdrawl from the principal sands of the Chicot aquifer amounts to about half the total ground water pumped in Louisiana. Since 1946 the rate of average ground-water withdrawals for industrial purposes in southwestern Louisiana has increased from 50 m.g.d. to 110 m.g.d. (million gallons per day). Of this total 60% is from industrial wells in the Lake Charles area. In 1957 the average ground-water pumpage for all purposes in southwestern Louisiana was 577 m.g.d., or 1,770 acre-ft. per day.

Since 1955 the regional water level in the Chicot aquifer has been virtually in equilibrium with the rate of pumping. Locally, however, in areas of increased or heavy withdrawals, such as at Lake Charles, water levels continue to decline at a uniform rate.

The total Fe content in water from sands of the Chicot aquifer at Lafayette exceeds the recommended limit of 0.3 p.p.m. (part per million) for drinking water. However, the total Fe and the Mn contents in water from sands below 300 ft. at Lafayette are less than that from sands above 300 ft. in depth.--Auth.

2-958. Sniegocki, R.T. GEOLOGIC AND GROUND-WATER RECONNAISSANCE OF THE LOUP RIVER DRAINAGE BASIN, NEBRASKA: U.S. Geol. Survey, Water-Supply Paper 1493, 106 p., 3 illus., 9 maps (1 in pocket, scale 1:500,000), sec. (in pocket), 4 diags., 7 graphs, 12 tables, 1959, 30 refs.

The Loup River and its tributaries drain an area of about 15,230 sq. mi. in central Nebraska. The upper three-fifths of the drainage basin is in the Sand Hills region of Nebraska, and the lower two-fifths is in the loess plains and hills region. An eastward-thinning wedge of semiconsolidated and unconsolidated deposits of Tertiary and Quaternary age underlies the surficial dune sand and loess. These deposits, which are recharged by infiltrating precipitation, contain a tremendous volume of water - at least 400 million acre ft. - and annually discharge about 1.7 million acre ft. into streams. Although wells supply nearly all the water used in the area for municipal, rural domestic, and livestock requirements, and some of the water used for irrigation, the withdrawals are small compared to the yield that the ground-water reservoir is capable of sustaining. Moreover, it seems unlikely that withdrawals ever will equal the potential for ground-water development except, perhaps, locally. The U. S. Bureau of Reclamation has prepared plans for greater utilization of the surface-water resources of the basin - overland runoff and ground-water discharge into streams - for generation of hydroelectric power and irrigation of farmland both within the basin and in the adjacent lower Platte River valley.

The chemical characteristics of the ground and surface waters are uniform. The water is of the calcium bicarbonate type, generally contains less than about 500 p.p.m. of dissolved solids, and is suitable for irrigation and most domestic uses.--Auth.

2-959. Isbister, John. GROUND-WATER LEVELS AND RELATED HYDROLOGIC DATA FROM SELECTED OBSERVATION WELLS IN NASSAU COUNTY, LONG ISLAND, NEW YORK: New York, Water Power & Control Comm., Bull. GW-41, 42 p., 2 maps (1 in pocket, scale approx. 1 in. to 1 mi.), 2 secs., 3 graphs (1 fold.), 4 tables, 1959, 24 refs.

Nassau County has experienced a rapid growth in population and industry in the past 20 years that has resulted in increased development of its ground-water resources. The county is located in W.-central Long Island, and its boundaries enclose a land area of 274 sq. mi. The climate is relatively mild and precipitation averages 43 in. a year. The precipitation is the ultimate source of natural replenishment to the ground-water reservoir. Ground water is found in the pore spaces of unconsolidated sands, gravels, and clays which overlay a basement of crystalline bedrock.

Water levels in wells in Nassau County are continually fluctuating in response to changes in storage and head in the ground-water reservoir from both artificial and natural causes. The principal man-made causes of water-level fluctuations result from withdrawal of water from wells. Naturally caused fluctuations that have been identified are related to ocean tides, changes in atmospheric pressure, and seasonal variations in recharge from precipitation. Since Jan. 1932, the U. S. Geological Survey, in cooperation with the New York State Water Power and Control Commission and the Nassau County Dept. of Public Works, has maintained a continuing program of systematic measurement of water levels in selected observation wells. Records of water-level measurements for some of these wells are published in the Water-Supply Papers of the U. S. Geological Survey. This report presents almost 3,900 measurements of water levels not heretofore published and other related hydrologic data.--Auth.

2-960. North Carolina, Dept. of Conservation and Development, Division of Water Resources, Inlets and Coastal Waterways. WATER RESOURCES OF NORTH CAROLINA. [V. 10]. HIWASSEE AND LITTLE TENNESSEE RIVER BASINS: 75 p., map, Raleigh, North Carolina, 1959.

This publication comprises v. 10 of a series of 12 volumes containing information regarding water resources of North Carolina. Volumes 1 to 9 were published as follows: 1) State as a whole, Jan. 1955; 2) Neuse River basin, May 1955; 3) Yadkin-Pee Dee river basin, Aug. 1955; 4) Chowan River basin, Dec. 1955; 5) Roanoke River basin, Feb. 1957; 6) French Broad River basin, Nov. 1957; 7) Cape Fear River basin, Sept. 1958; 8) Broad and Catawba river basins, Oct. 1958; and 9) Tar-Pamlico river basin, Nov. 1958. Volumes 11 and 12 will provide inventories of the Kanawha and Watauga river basins and the Coastal Plain river basins, respectively. When these final volumes have been published, information pertaining to the entire state will be available to assist in the orderly planning and development of the water facilities required for municipal and industrial expansion and for expansion of the uses of water for agriculture, and to guide watershed authorities, basin associations, soil conservation districts, and other agencies concerned with water uses in accomplishing their purposes. --From foreword.

This volume on the Hiwassee and Little Tennessee river basins includes chapters on description of watershed, use of water for domestic and municipal rposes, agriculture, recreation, and electric wer, surface water, ground water (occurrence l movement of ground water, factors affecting lds of wells, rocks and their water-bearing characteristics, and ground water in the Hiwassee and Little Tennessee river basins), quality of water, abatement of stream pollution, and watershed management.

## 12. MINERAL DEPOSITS

e also: Geologic Maps 2-790, 2-818; Areal and Re- onal Geology 2-823, 2-830, 2-831; Geophysics 2-906; gineering Geology 2-1006.

961. Goodman, Richard E. PHOTO/FIELD OSPECTING: Photogramm. Eng., v. 26, no. 1, 100-105, March 1960, 6 refs.

The value of aerial photographic interpretation in ploration for mineral resources is becoming firm- established as the search for minerals is extended remote regions of the earth.

This paper points out those terrain features which e significant to the search for primary ore deposits bedrock; and for secondary or placer accumulations transported, unconsolidated deposits. Also dis- ssed are methods of integrating photo interpretation th geochemical and geophysical prospecting tech- ques, and uses of air photos in staking mining aims.--Auth.

962. Kasper, R.J. GRAVEL PROSPECTING USE OF AERIAL PHOTOGRAPHIC INTERPRE- TION (In: Soil and Materials Surveys by Use of erial Photographs: Natl. Research Council, High- ay Research Board, Bull. 213 (Natl. Acad. Sci.- tl. Research Council, Pub. 666), p. 44-52, 3 us., 4 maps, table, 1959)

The North Dakota State Highway Dept. has at- mpted to utilize all available scientific methods of ospecting for gravel because of a rapidly dimin- ning aggregate supply and a greatly increased high- y construction program. Geology, aerial photo- aphic interpretation, and geophysics are being mbined as a research unit for the reconnaissance d exploration of sand and gravel deposits situated an economically important location to the inter- te highway system.

The 3 physiographic provinces of North Dakota e discussed separately, and the geologic situation the state is given briefly. In general North kota represents a "transitional zone where sand d gravel were transported by different agents from rying directions. Those agents of erosion most olved in the conveyance of material from its urce to its present depositional locality are glacial w and stream flow."

Under the new gravel search program, the first ea designated for aerial photographic research tends approximately 50 mi. eastward from Bis- rck and 10 mi. on each side of and paralleling esent US 10. This area lies within the eastern tion of the Missouri plateau and is partially vered by the Altamont end moraine complex. The ocedure followed in the study of this area is de- ibed. The paper concludes with some general nments on the role of aerial photographs in ving field problems.--L. M. Dane.

963. Weinberg, Alvin M. BREEDER REAC- RS: Sci. American, v. 202, no. 1, p. 82-94, 6 ıs., 5 diags., Jan. 1960.

Reactors that produce more fuel than they consume make it feasible to use the uranium and thorium in rocks such as granite rather than the rich ores presently required. The greater part of the paper deals with breeder reactor design, principles, and plants being built or planned. In a section on energy economics, it is pointed out that sea water can be used as a source of deuterium when controlled fusion is accomplished, providing a source of supply good for more than 10 billion years at a predicted rate of 40 billion kilowatts per year. The granite required for breeder reactors would be about 10 million tons a day. The disposal of huge quantities of radioactive wastes may be accomplished in salt domes, deep natural wells, or artifically created cracks in the earth.--M. Russell.

2-964. Dean, Basil G. SELECTED ANNOTATED BIBLIOGRAPHY OF THE GEOLOGY OF URANIUM-BEARING VEINS IN THE UNITED STATES: U.S. Geol. Survey, Bull. 1059-G, p. 327-440, map (in pocket), 1960.

This bibliography of 211 annotated references lists reports available as of June 1957. The annotations, arranged alphabetically by author, emphasize the geologic aspects of veins that contain U. An index map shows the location of vein deposits referred to in the annotations. Indexes are provided with entries listed according to author, geographic area, and subject.--Auth.

2-965. Schanz, John J., Jr. THE NOT-SO-RARE EARTH METALS: Mineral Industries, v. 29, no. 4, p. 6-7, table, Jan. 1960.

The La rare earths are a closely related group of elements which, despite their name, are as abundant as many of the "common" metals. The chemical reactivity of the group and the similarity of its members have created many difficulties in isolating, identifying, and utilizing the rare earth metals.

The principal commercial source of the rare earths is monazite. This has placed the rare earth metals in close relationship to Th both geologically and in commercial use. The separation of the several heavy minerals which may occur together in the as-mined ore, followed by the isolation of the individual rare earth oxides, and finally the refining of the oxides to metal, is a long, complicated, and expensive process. Ion exchange separation has been important in making possible better separation of the individual oxides.

Most of the rare earth materials consumed are in the form of mixed oxides or metals. The individual oxides or metals are still quite expensive though there have been significant reductions in their prices in recent years. The uses of the rare earths are quite varied and constantly growing in number. However, the greatest quantities are used in the manufacture of special glass products, pyrophoric alloys, and other metallic alloys.--Auth.

2-966. Ridge, John D. THE UNUSUAL MANGANESE-IRON DEPOSITS OF LÅNGBAN IN SWEDEN:

Mineral Industries, v. 29, no. 3, p. 1-5, 9, port., 2 maps, 2 secs., Dec. 1959, 9 refs.

The Mn-Fe deposits at Långban are unusual in that: 1) the Fe and Mn minerals are in distinctly separate deposits, though these usually adjoin or are close to each other; 2) the more oxidized Fe and Mn minerals are earlier than the less oxidized ones; 3) the skarn silicates of the Mn ores contain uncommon manganese silicates and quite rare lead silicates, both of these being, however, of the same general categories as make up the wall-rock alteration minerals of contact metasomatic deposits (hypothermal deposits in calcareous rocks); 4) there are few sulfides in the deposits, but there is a wide representation of oxy-salt anions, the metal ions of which are normally found in sulfo-salts; and 5) native metals, most of which are very rare in ore deposits, are present in appreciable amounts at Långban. The explanations put forward for these conditions depend on 2 assumptions: 1) that free O was available to oxidize all of the initial supply of Fe and most of that of Mn to the +3 state and 2) that later this Fe$^{+3}$ and Mn$^{+3}$ and certain metal ions in the ore fluids which followed joined to oxidize much of the sulfide in solution to sulfate and to be reduced themselves to a lower valence or even to the native state. The similarities and differences between the Långban deposits and those of Franklin, New Jersey are also discussed.--Auth.

2-967. Murphy, Thomas D. DISTRIBUTION OF SILICA RESOURCES IN EASTERN UNITED STATES: U.S. Geol. Survey, Bull. 1072-L, p. 657-665, 9 maps (in pocket), 1960, 32 refs.

The general distribution of silica resources (minimum $SiO_2$ content 95% ) E. of the Mississippi River is shown on 8 maps. Location of silica operations active in 1955 is indicated on a separate map. The text, which is an expanded explanation and introduction to these maps, includes definitions and uses of various types of silica raw materials, and specifications of significance to the silica industry.--Auth.

2-968. McGrain, Preston, and Thomas J. Crawford. HIGH-SILICA SANDS IN CALLOWAY AND CARLISLE COUNTIES, KENTUCKY: Kentucky Geol. Survey, Inf. Circ. 2, Ser. 10, 14 p., 4 figs., 1959, 2 refs.

Exploration of a N.-S. ridge between Blood River and Beechy Creek S. of New Concord, Calloway County, revealed more than 20,000,000 tons of unconsolidated high-silica sands of Ripley age [Upper Cretaceous] suitable for many purposes in the glass and foundry industries. An estimated 6,200,000 tons of the raw sand are considered minable by conventional open-pit methods. The northern portion of this ridge, as yet unexplored, may provide an additional reserve. This sand is amenable to beneficiation by mechanical treatment.

A deposit of high-silica Eocene sand in western Carlisle County, situated strategically with respect to transportation facilities, has potential economic value for abrasives, foundry, grinding, and construction purposes.--P. McGrain.

2-969. Bowen, Oliver E., Jr., and Cliffton H. Gray, Jr. GEOLOGY AND ECONOMIC POSSIBILITIES OF THE LIMESTONE AND DOLOMITE DEPOSITS OF THE NORTHERN GABILAN RANGE, CALIFORNIA: California, Div. Mines, Spec. Rept. 56, 40 p., 41 figs., incl. 36 illus., geol. map and secs. (in pocket, scale 1 in. to 1,320 ft.), 1959, 21 refs.

This paper describes in some detail the geology of 8 sq. mi. in the vicinity of Fremont Peak and also includes a discussion of the general geologic features of the northern Gabilan Range. Most of the known masses of carbonate rock in the area are described.

Deposits of limestone and dolomite in the northern Gabilan Range are important sources of raw materials for San Francisco Bay area industries, supplying 1 cement plant and 3 magnesia refractory and chemical plants. The deposits occur chiefly in the crystalline basement complex of the range, as pendants in granitic rocks and schist. Some of the pendants contain masses of limestone and dolomite of commercial size and purity, whereas others contain mixed calcitic and dolomitic rocks of no present economic importance. Criteria useful in recognizing calcitic and dolomitic rocks in the Fremont Peak vicinity are grain relief, grain size, and grain color, as seen on weathered surfaces, and the disposition of solution pits. The more siliceous varieties of carbonate rock are also likely to be magnesian.

The major rock units of interest in the area are the metamorphosed Sur series of probable Paleozoic age, undivided granitic rocks, chiefly quartz monzonite and granodiorite of Jura-Cretaceous age, and the Vaqueros group of lower Miocene age. Carbonate rocks of potential commercial importance occur in the Sur series and the conglomerate portions of the Vaqueros group.

Sur series rocks, in descending order of abundance, are quartz-mica schist, limestone, dolomite, and quartzite. An upper and lower schist member and a middle carbonate-and-schist member are recognized. Subunits mapped for economic purposes in the Fremont Peak vicinity are: limestone; dolomite; limestone with granitic rock and schist intercalations; mixed limestone and dolomite; siliceous limestone; limy, siliceous dolomite; gray replacement quartz; quartz-mica schist; pink quartzite; mixed schist and granitic rocks; and quartz monzonite-granodiorite. Vein and replacement masses of barite occur in the carbonate rocks W. of Fremont Peak.--C. H. Gray, Jr.

2-970. Hart, Earl W. GEOLOGY OF LIMESTONE AND DOLOMITE DEPOSITS IN THE SOUTHERN HALF OF STANDARD QUADRANGLE, TUOLUMNE COUNTY, CALIFORNIA: California, Div. Mines, Spec. Rept. 58, 25 p., 3 pls., 19 illus., 2 figs., 3 tables, 1959.

The limestone and dolomite deposits of the southern half of the Standard 7 1/2 min. quadrangle lie in the western foothills of the Sierra Nevada a few miles E. of the Mother Lode Au belt. They are part of the southern extension of that immense limestone-dolomite complex so well exposed within Sonora-Columbia area.

The oldest rocks in the mapped area, of which the carbonate rocks are part, are elements of the Carboniferous(?) Calaveras group, which consists of a highly deformed sequence of metamorphosed marine sedimentary rocks. The predominant rock types comprising this sequence are limestone, dolomite limestone, quartz-mica schist, micaceous quartzite, metachert, quartz-mica hornfels, and tectonic mixtures of these rocks. Granodiorite of Upper Jurassi to Cretaceous age has intruded the Calaveras group, and its emplacement is at least partly responsible for the arcuate distribution of the metasedimentary rocks. Migmatization and allied contact metamorism of the Calaveras rocks have also resulted from is influx of granitic material. Associated with e granodiorite are numerous dikes and sills of orite, leucogranite, and pegmatite. A single mnant of Tertiary gravels and upper Miocene(?) ffaceous rocks unconformably overlies the Cala- ras group.

Structurally, the Calaveras rocks are highly lded and longitudinally sheared. The bedding and liation generally are steeply dipping to vertical d are parallel to subparallel to each other and to e Calaveras-granodiorite contact. Although struc- ral features cannot be mapped with certainty, the parent eastward thickening of the Calaveras rocks dicates the existence of numerous isoclinal folds ich are probably components of an E.-plunging mpound syncline.

Limestone and dolomite of high-Ca and high-Mg ntent, respectively, are the principal mineral mmodities of current economic importance in the ea. Eleven deposits of limestone exist and appear be suitable for use in the portland cement, lime, emical and steel flux industries. Five dolomite posits appear to be of high enough quality for use the manufacture of refractories. These undevel- ed deposits are easily accessible, close to rail cilities, and a reasonable distance from the San rancisco Bay marketing area.--Auth.

-971. Moxham, Robert M., Richard A. Eckhart, d Edward H. Cobb. **GEOLOGY AND CEMENT RAW ATERIALS OF THE WINDY CREEK AREA, LASKA**: U.S. Geol. Survey, Bull. 1039-D, p. 67- 00, 4 illus., 2 maps (incl. geol. map in pocket, ale 1:48,000), 7 tables, 1959, 16 refs.

The Windy Creek area, on the S. flank of the laska Range, is within a geosynclinal belt that con- ins clastic and calcareous rocks ranging in age om pre-Devonian to Late Cretaceous. The major ologic structures in the area are oriented parallel the regional easterly to northeasterly trend of the laska Range. Steeply dripping folded strata of esozoic age occupy the southern part of the area d have been downthrown against Devonian rocks on e N. by a major fault zone that crosses the center the area.

Two limestone deposits of Devonian and Devoni- (?) age are of adequate size and chemical quality r cement-manufacturing purposes. They are cated 7 and 11 mi., respectively, W. of the Alaska ailroad. A third limestone deposit of large size t of inferior quality lies 1 mi. W. of the railroad. rgillaceous rocks, which occur in both the pre- evonian, Devonian and Jurassic(?) systems, are und in many parts of the area. Chert of Triassic e, possibly of some value as a high-silica com- nent, occurs along the Alaska Railroad near Windy ation.--Auth.

-972. Johnson, Paul W. **THE EMERALDS OF HIVOR TODAY**: Lapidary Jour., v. 13, no. 4, p. 6, 518-520, 522, 524, 12 illus., Oct. 1959.

A brief history of the mines at Chivor, Colombia, given along with remarks upon the productive eas, the current methods of mining, and the occur- nce of emeralds. The famous Patricia emerald w in the American Museum of Natural History is entioned.-- J. Sinkankas.

-973. Leiper, Hugh. **IS THERE PRECIOUS OPAL HONDURAS?**: Lapidary Jour., v. 13, no. 4, p. 568, 570-572, Oct. 1959.

Kunz' remarks on the opal fields of Honduras in his "Gems and Precious Stones of North America" are extensively quoted and comprise the main portion of the text. The experiences of Henry Lindhe of Austin, Texas, who visited the area in 1953 are briefly recounted, and the conclusion is drawn that deposits of precious opal still exist.--J. Sinkankas.

2-974. Zaveri, C. K. **GEM MINING IN INDIA**: Lapidary Jour., v. 13, no. 4, p. 546-548, 550, 552-556, Oct. 1959; no. 5, p. 618, 620, 622, 624, 626, 628, Dec. 1959, 7 illus., map.

Pt. 1 introduces the series by briefly discussing the geography of India and the gem mining industry. The following economically important gemstones are mined today: emerald, chrysoberyl, garnet, star ruby, aquamarine, amethyst, moonstone, aventurine, chalcedony varieties, corundum (sapphire). Also mined, but less important, are: apatite, apophyllite, euclase, iolite, kyanite, rhodonite, tourmaline, spinel, beryl, and calcite. A brief history of diamond mining in India is given along with a few data upon some famous Indian diamonds and methods of mining. At present the only sources of diamonds are the mines at Panna in Vindhya Pradesh, Bundelkhand; another locality is given as the Kistna river bed in Andrha state of S. India. General remarks are furnished upon Kashmir sapphires, emeralds, garnets, tourmalines, and sapphirine quartz, the only gemstones currently mined in northern India.

Pt. 2 deals with the gemstones of southern India where by far the largest variety and quantity are obtained today. Only the states of Madras and Mysore produce large amounts. Madras can be compared to Brazil in this respect, while the Salem district of this state is especially rich. Aquamarine is largely obtained from alluvium or shallow workings in weathered surface material in the area surrounding the village of Kangyam; amethyst, iolite, and orthoclase moonstone are also found in this area. Other areas in Madras state furnish apatite, rock crystal, sapphire, star ruby, garnet, tourmaline, brown enstatite, kyanite, feldspar, beryl, euclase, andalusite, sunstone, chrysoberyl, spinel. Mysore state produces star ruby, green aventurine, and Au (Kolar). The opaque, dull red star ruby, really red corundum, is briefly described. Chalcedony varieties abound near Aurangabad in the state of Bombay, large agate nodules are recovered from the gravels of the Godawari River, optical calcite is found in the same district. Carnelian is obtained in considerable quantity near Jhagadia near Baroda in Bombay state and marketed in Cambay.--J. Sinkankas.

2-975. Wisser, Edward. **RELATION OF ORE DEPOSITION TO DOMING IN THE NORTH AMERICAN CORDILLERA**: Geol. Soc. America, Mem. 77, 117 p., 34 figs. incl. maps (2 fold.), secs., diags., 1960, 163 refs.

Many structural domes and anticlines rise from undeformed surroundings; the general crust of the earth is neither shortened nor extended by these local swells or blisters, but the area of the plate upfolded is increased. With plastic material the increase is effected largely by flow, with brittle material, largely by fracture.

Many mining districts are associated with upfolds of this type. Districts here described fall into 2 categories: 1) those whose structural frame is a dome, and 2) those whose structural frame is an anticline.

Domes may show fractures which radiate from the apex, or concentric fractures which are segments of circles, of varying diameters but with a common center, the apex of the dome. Both types may appear on the same dome; the fractures of each type aid enlargement of the plate during doming.

Sunlight and Kirwin, Wyoming, are minor districts with dominant radial fracture patterns. Vein matter was deposited while the walls of the vein fractures were being pulled apart. With a radial vein system the only way in which all the vein walls could be simultaneously pulled apart is by stretching of the fabric of an expanding dome.

The structural setting of the Ophir, Utah, Pb-Ag district, and of the Matehuala, Mexico, Cu district is that of a half dome truncated by a normal fault with downthrow away from the domical apex. Displacement on the fault is greatest opposite the apex and decreases progressively in both directions, becoming zero at the spring line. No part of the dome ever existed on the downthrown side of the fault, which was a fracture before doming. Maximum uplift was centered on one side of the fault and there produced the half dome; but the preexisting fracture offered locally an easier mode of uplift by rise of the footwall block.

At Ophir, ore shoots followed intersections on the half dome of radial fractures with limestone beds. At Matehuala, stretching during doming was effected largely by flow of limestone, but a monzonite stock intruded in the half dome was too brittle to flow. The limestone pulled away from the unyielding stock; fractures concentrated around the periphery of the stock localized the Dolores Cu ore bodies.

In the Silverton-Telluride district, Colorado, fractures radiate from a relatively large, roughly circular graben, along whose margin monzonitic stocks were intruded. Evidence suggests that this fracture pattern resulted from domical uplift, with the graben at the apex. Transfer of volcanic material from depth to the surface in the central area produced a sag which has eliminated the upward bulge of the dome.

Mineralization advanced outward from the graben step by step with the outward growth of the radial fractures. Cu-Ag pipes within the fault zone bounding the graben were formed first, followed successively outward by base-metal deposits as veins, which were reopened to admit Au and Ag, and by precious-metal vein deposits in the outermost zone.

The structural setting of La Plata, Colorado, is that of a dome, truncated S. of its apex, by a zone of high-angle faults striking eastward. Displacements on the faults are greatest opposite the domical apex. The doming is accentuated by a horseshoe-shaped hinge fold, open on the S. Along the fold, dips of the strata steepen sharply; outside it, dips are gentle, whereas inside it, they are nearly flat. Several stocks were intruded along the fold, and others inside it. The steep flexural fold and abundant intrusions suggest upward shove of a flat-topped piston, perhaps a magma column congealed in its upper part, but fluid and under pressure below.

Fractures are abundant along the horseshoe fold, and, with respect to the dome, fall into 2 classes, radial and concentric. Au-Ag deposits were concentrated chiefly within or near the horseshoe fold, and in the eastward-trending fault zone. Doming, which began during the intrusive epoch, persisted through the period of metallization, because at that time older fractures were reopened, new radial and concentric fractures were created, and fractures of both generations became loci for ore bodies.

The structure at Rico, Colorado, is that of a dome with eastern elongation. Superimposed upon the major dome, toward its eastern end, is a doubly plunging anticline, also with easterly trend, cut by fractures which parallel its axis, and by fractures normal to the axis. Rich ore bodies were localized at a stratigraphic horizon originally occupied by a bed of gypsum which was dissolved, leaving silty material which the ores replaced. Ribbon-shaped mantos lay directly above fractures, both of the longitudinal and transverse sets. Ore solutions ascended these fractures to form the mantos during late stages of the doming.

The Goldfield, Nevada, district lies on the SW. flank of a dome encircled by a belt of intense alteration, and of complex fracturing, which probably coalesces at depth into 1 or more persistent faults concentric with respect to the domical apex, and which formed the channel for altering and metallizing solutions. The volcanic rocks were brittle when first fractured by doming, but solutions rising along the fractures of the circular belt softened the rock by alunitization and kaolinization. Silica-bearing solutions then created the irregular silica "ledges" at horizons close to the then surface. The soft rock encasing the ledges flowed, as doming persisted, but the brittle ledges fractured. Ledges which had no "keel" below them were inaccessible to Au-bearing solutions; those with keels extending down to the main ore channel received the rich ore bodies.

Many mining districts are associated with doubly plunging anticlines, which with brittle rock are broken by fractures which strike parallel or normal to the axis.

At Creede, Colorado, older extrusive rocks were flexed into a N.-trending anticline. Younger extrusive rocks do not share in the folding, but faults which strike parallel to the anticlinal axis and dip toward it cut and displace both older and younger rocks; they form a graben along the crest of the buried anticline. These faults originated as tension fissures, the result of arching of the older volcanic rocks. After extrusion of the younger volcanic rocks renewed uplift was concentrated along the abutments of the arch, in the footwalls of the graben faults. These faults were propagated upward through the younger volcanic rocks.

The eastern graben fault, the Amethyst, fingers out at its southern end. Most of the Ag ore of the district came from the southern segment of the Amethyst vein. Here intense local uplift in the footwall, unable to utilize the split-up fault as a lubricated plane of movement, tore apart the walls to permit entry of the Ag-bearing solutions.

The structure at Bodie, California, is that of an irregular anticline upon which are superimposed several domes. The country rock is volcanic. Most of the faults and veins strike parallel to the anticlinal axis and dip toward it; but the Fortuna fracture which carried the richest ore body, lies in anomolou relation to the anticline, for it is neither a longitudinal nor a cross fracture. It seems to have resulted from an earlier deformation, but to have been utilized by the uplift which formed the anticline in such a way that its flat segment gaped open to admit rich Ag- and Au-bearing solutions.

Guanajuato, Mexico, lies on the NE. flank of a major anticline which plunges SE. The anticline carries a crestal graben. The graben fault on the NE. flank is the Veta Madre, with maximum displacement on the NW.; displacement decreases progressively southeastward, in the direction of plunge

the anticline. Like the Amethyst fault at Creede,
Veta Madre originated as a tension fissure, but
came an antithetic fault when the arch broke into
gments under continued uplift. Major Ag-ore
ies on the Veta Madre were localized where dif-
ential movement of the walls brought shallow cups
the footwall surface opposite planar areas in the
nging-wall surface.

At El Oro, Mexico, the attitudes of remnants of
andesite flow overlying shale, together with the
cture pattern, indicate deformation to form a
anticline trending N.-northwestward.

The San Rafael vein lies along a normal fault
iking parallel to the anticlinal axis, with down-
ow on the W., toward the axis. Faulting had been
mpleted by the time of mineralization. Early,
-grade vein matter welded the fault, but arching
ntinued and with it an urge toward resumption of
lting, prevented by the welding. The resulting
ong shearing strain produced a number of verti-
feather-joint branches in the hanging wall of the
ult. These were mineralized by solutions rich in
and Ag.

The Mogollon, New Mexico, district lies on the W.
nk of a large anticline trending and plunging N.-
rtheastward. The Pacific-Great Western and
een faults strike parallel to the anticlinal axis and
eastward toward the axial plane. The block be-
een these faults contains a local bulge truncated
the E. by the Queen fault. Displacement on the
ult is greatest opposite the crest of the bulge and
creases progressively in either direction. The
cal uplift in the footwall increased the displace-
ent on the Queen fault, but it took place in the hang-
wall of the Pacific-Great Western fault. The
iginal displacement was reversed in the segment
fected by the bulge.

The bulge has the form of a doubly plunging anti-
ine trending northward, parallel to the Queen and
cific-Great Western faults. The chief productive
ins of the district occupy cross-fractures normal
the anticlinal axis. Most of those N. of the high-
t point on the up-bowed axis dip southward, where-
most of those S. of that point dip northward.
ese fractures gaped open, under continued bulging,
time to receive the richest surge of Ag-Au solu-
ns.

The following generalizations appear valid.

Uplift in these districts was accompanied by de-
lopment of tension fissures. Uplift and consequent
retching of the arching plate persisted through the
riod of mineralization, but by this time stretching
many areas had reached a stage at which fissuring
uld no longer facilitate it; fissuring was succeeded
graben and antithetic faulting. Ore deposition
metimes preceded this faulting but more often fol-
wed it.

The fracture pattern on these domes and anticlines
veloped as uplift progressed. Solutions deposited
in matter in those fractures which were permeable
the time and accessible from the main solution
annel.

Mesothermal deposits associated with domes and
ticlines fall into groups defined by age of mineral-
ation and by metallographic provinces, but epither-
al deposits are scattered from one end of the Cor-
leran region to the other. They show, however,
preference for major uplifts. Silverton, Rico, La
ata, and Creede lie on a tectonic element marked
recurrent uplift from the close of the Paleozoic
the Pleistocene. Epithermal deposits in Mexico
e concentrated on the site of the persistently posi-
e Occidental geanticline. The crystalline basement lies deep throughout much of Nevada, but Goldfield, Tonopah, and other epithermal districts lie above or close to relative highs in the basement which are much larger than the local uplifts with which these districts are associated.

These major uplifts were developing while epithermal metallization was taking place. The whole Cordilleran region was fast assuming its present shape. The local phenomena of uplift, fissuring, intrusion, and metallization were satellitic features superimposed on the uplift of the Cordilleran region as a whole. Because of this fact, a deep-seated origin for epithermal ores is suggested.--Auth.

2-976. Field, Doris J. MINING OPERATIONS IN 1957: Ontario Dept. Mines, Ann. Rept., v. 67, pt. 2, 1958, 183 p., tables, pub. 1960, refs.

Only those mines or mining properties that have reported actual mining or development operations for the year 1957 are included in this report. Properties are briefly described under the following headings: asbestos, copper, copper-lead-zinc, fluorspar, gold, gypsum, iron, lead, lithium, magnesium, nepheline syenite, nickel and copper, niobium, (columbium), salt, silver and cobalt, talc, uranium, vermiculite. Ten metallurgical works are also briefly described.

2-977. U.S. Congress, Senate, Committee on Interior and Insular Affairs. ALASKA MINERAL LEASING. Hearing before the Subcommittee on Public Lands...86th Congress, 1st Session, June 19, 1959: 63 p., fold. map, Washington, D.C., U.S. Govt. Print. Off., 1959.

Contains statements on S. 1855, a bill to increase the maximum acreage that any one person can hold under oil or gas lease or option, combined, on federal lands in Alaska to one million acres; S. 1723, a bill to increase the maximum acreage any one person may hold under coal lease in Alaska to 30,720 acres; S. 1412, a bill to extend for five years from admission the time within which Alaska may select lands under federal mineral lease.

2-978. Davis, Fenelon F., and others. CALIFORNIA MINING EVENTS, 1959: California, Div. Mines, Mineral Inf. Service, v. 13, no. 2, p. 1, 14-16, illus., Feb. 1960.

The total value of California mineral production declined in 1959 for the second straight year. The estimated value is $1,433,000,000, off about 4% from the 1958 total of $1,500,000,000 (revised). The value of production in the fuel and metal groups continued to decline. Au production dropped to the lowest point in 15 years, the second lowest level in the history of the state. The brightest spot in the mining picture appeared in the industrial minerals group where the value of production advanced about 8% over 1958, as 6 commodities established all-time highs in quantity and value of production.--Auth.

2-979. Schoewe, Walter H. THE MINERAL INDUSTRY IN KANSAS IN 1958: Kansas, State Geol. Survey, Bull. 134, pt. 7, p. 239-287, 3 maps, 41 tables, 1959, 17 refs.

In 1958, for the third consecutive year, the value of Kansas mineral production exceeded $500,000,000. Minerals produced in the state were valued at $514,234,445, or approximately $19,859,000 less than in 1957, a decrease of 3.7%. Of this total, $440,976,227 or 85.7% was derived from sale of mineral fuels and associated products, $72,052,368 or 14% was contributed by the nonmetals excluding mineral fuels, and $1,205,850 or 0.3% by the metals. Salt brine, cement, both natural and portland, coal, diatomaceous marl, LP gases, propane, sand and gravel, and stone were produced in greater quantity in 1958 than in the previous year, and the values of brine, carbon black, cement, coal, gypsum, marl, sand and gravel, stone, and vermiculite produced in 1958 were greater than those of the same minerals produced in 1957.

Only 3 of the 105 counties in Kansas reported no mineral production in 1958. Oil, gas, or both were produced in 78 counties, sand and gravel in at least 66, and stone in 46. In 1958, each of 54 counties produced minerals worth $1,000,000 or more. As in 1957, Barton County, with a production value of $35,293,535, continued to lead all others. Ellis County, with $34,177,827, was second, and Russell County, with $27,228,855 was third. Most important minerals produced per dollar value were oil, natural gas, cement, stone, clay and clay products, salt, sand and gravel, natural gasoline, carbon black, coal, propane, and butane. This report gives the production and value of all minerals produced in the state in 1958 and compares them with 1957, and it also includes directories of mineral producers on record as of Dec. 31, 1958.--From auth. abs.

**2-980. Johnson, Henry S., Jr. GEOLOGIC ACTIVITIES IN SOUTH CAROLINA DURING 1959: South Carolina, State Devel. Board, Div. Geology, Geol. Notes, v. 4, no. 1, p. 1-7, Jan.-Feb. 1960,**

According to the U. S. Bureau of Mines, mineral production in South Carolina reached an all time high in 1959 with a total value of $27 million. This was an increase of about 20% over production for 1958. The principal mineral industries were cement production, the mining and processing of kaolin and other clays, and the production of crushed stone. South Carolina ranked second in the states in output of kaolin, kyanite, and vermiculite. Cement production increased 39% in value. Kaolin production increased 22% in tonnage and 14% in value. Stone production increased 6% in tonnage and 12% in value. Mining of placer ilmenite, rutile, zircon, monazite, and staurolite ceased, but shipments of Ti concentrates continued from stocks. Kyanite and vermiculite output and values increased substantially over 1958. Feldspar concentrates and glass-grade silica came into production from a new source during the year.--Auth.

The following projects are discussed briefly: limestone and marl of the Coastal Plain; minerals industry; results of exploration for heavy minerals on Hilton Head Island; siliceous clays of the Coastal Plain; geology and mineral resources of Pickens, Newberry, and Orangeburg counties; geology of Blaney, and Fort Jackson North quadrangles; and Waccamaw and Croatan deposits of the Carolinas. Shorter investigations were conducted on: Coastal Plain clays, Medway type; Foxville clay deposit, Sumter County; Newlin bentonite deposit, Jasper County; preliminary investigations of geology and mineral resources of Sumter County; Little Mountain, Newberry County, silica sand of Blaney area, Kershaw County; Calhoun Falls gabbro, Abbeville County; airborne radioactivity check; kaolin; limestone for cement manufacture; drilling for stratigraphic information; age determinations; and oil lease. The publications of the Division of Geology during 1959 are also listed.

**2-981. U.S. Bureau of Mines and South Dakota, State Geological Survey. MINERAL PRODUCTION IN SOUTH DAKOTA IN 1959: South Dakota, State Geol. Survey, Minerals Rept. 6, 7 p., chart, table, Feb. 1960, ref.**

South Dakota mineral production in 1959 was valued at $44.6 million, an increase of 7% over 1958.

Nonmetal production represented 52% of the total value of the state's mineral production and was 14% greater than in 1958. Major gains in value of production were noted in cement, clays, and sheet mica.

Value of metal production was 1% greater than in 1958 but represented only 48% of the value of the state's mineral production. Major declines in value of Be concentrate and Ag were noted, and only a modest increase in the value of Au production.

Petroleum production advanced 47% in value compared with 1958 but the value of coal (lignite) output increased only a modest 3%.--Auth.

**2-982. Thorsen, Gerald W. DIRECTORY OF WASHINGTON MINING OPERATIONS 1959: Washington, Div. Mines & Geology, Inf. Circ. no. 34, 78 p., 2 maps, table, 1960.**

The current directory, like those published in the preceding years, is designed to provide information on all companies, agencies, or individuals who are producing minerals or mineral aggregates in Washington. The names of the concerns and of the mines or other properties are listed, together with addresses, locations, and the minerals produced. In most instances the concerns listed are currently operating; some, however, are in a development or exploration stage but expect to produce in the near future. The data used are from the files of the Divison of Mines and Geology and have been obtained principally through personal contacts with the operators at their mines, quarries, or places of business.

Sand, gravel, and common crushed-rock operations include all the known commercial producers, as distinct from state, county, and railroad pits and quarries. As the emphasis is on operations of some permanence, the many pits of the Washington Dept. of Highways are not listed individually because of the temporary or intermittent nature of their production. The rock referred to is mostly used for road-building purposes. That used for riprap, breakwaters, and dimension, architectural, and landscape stone is listed in the nonmetallic section of this report.--Fro foreword.

Contents:

Statistics of Washington mineral production
Metallic mining operations
Nonmetallic mining operations
Sand and gravel operations
Property index
Metallic product index
Nonmetallic product index
County index

lso: Geologic Maps 2-788, 2-789, 2-815; Geo-
cs 2-903; Sedimentary Petrology 2-940; Mineral
its 2-981.

3. American Petroleum Institute. PETRO-
M FACTS AND FIGURES. CENTENNIAL EDI-
N, 1959: 472 p., chart, graph, tables, New York,
, 45 refs.

he centennial edition brings together authorita-
current and historical information which will be
lue to oil men, students, educators, journalists
all others interested in the statistical story of
oleum. Because it traces these data as far back
ossible, this edition supersedes all earlier
ons.--From foreword.

ontents:
lights of a hundred years, p. 1-4.
uction Section, p. 5-87.
ning Section, p. 88-148.
nsportation Section, p. 149-203.
keting and Utilization Section, p. 204-369.
es and Taxation Section, p. 270-409.
eral - finance, labor, fire & safety, world data,
onversion tables, p. 411-457.
sary, p. 458-462.

34. Scheidegger, Adrian E. AN EVALUATION
THE ACCURACY OF THE DIFFUSIVITY EQUA-
N FOR DESCRIBING MISCIBLE DISPLACEMENT
OROUS MEDIA: 16 p., diag., graph, 4 tables,
gary, Canada, Imperial Oil Research Laboratory,
, 12 refs.; reprinted from: Proceedings of the
ory of Fluid Flow in Porous Media Conference,
ch 23-24, 1959, p. 101-116.

he theoretical description of miscible displace-
t in porous media (where the fluids have a unit
osity and a unit density ratio) is usually based
the diffusivity equation which is known to give
itatively correct results. In this paper the ac-
cy of the diffusivity equation for the description
iscible displacement is more closely scrutiniz-
Results of experiments are reported where mis-
displacement was arranged to take place in
ar porous media. For each experiment, the best-
ng constant in the diffusivity equation ("factor of
ersion") was calculated by a least squares meth-
After this factor of dispersion had been deter-
ed, it was possible to calculate theoretical values
he concentration and to compare the latter with
actually observed values. It was found that the
age root mean square deviation between the 2
of values is 0.03 which must be considered as
standard error expectable if the diffusivity equa-
is used to describe miscible displacement. Thus,
experiments confirm the diffusivity equation up
is standard error. The deviations are system-
which appears to point towards an additional,
erto unknown, effect.--Auth.

5. Scheidegger, Adrian E. ON THE STA-
TY OF DISPLACEMENT FRONTS IN POROUS
IA: A DISCUSSION OF THE MUSKAT-ARONOF-
MODEL: Can. Jour. Physics, v. 38, no. 2, p.
162, 4 diags., Feb. 1960, 6 refs.

is well known that, during the displacement of
id contained in a porous medium by another less
ous one, the displacement front may become un-
le. Fingers occur which proceed rapidly through
system.
he Muskat-Aronofsky model of displacement in
us media, in which it is assumed that a sharp front exists with maximum saturation by the respective fluid being present on either side of the front, is analyzed in the light of the phenomenon of fingering. It is shown that the Muskat-Aronofsky model, in fact, demands that fingering occurs for mobility ratios (displaced/displacing fluid) smaller than one. This model should, therefore, not be used for the calculation of the steady progress of a front for such mobility ratios. The Muskat-Aronofsky model also yields some conditions regarding the geometry of fingers; the latter are deduced. It does not, however, describe the fingering process completely. In this connection, one would have to take recourse to the statistical geometry of porous media. This will be done in a separate paper.--Auth.

2-986. Lewis, Paul J. HOW TO ANALYZE BIOHERMS IN THE WILLISTON BASIN: World Oil, v. 150, no. 2, p. 82-84, port., 6 illus., Feb. 1960, 4 refs.

Bioherm facies of Mission Canyon (Mississippian) are producing, and comparisons will help to find other desirable places. Bioherm rock mounds up to 3 1/2 mi. in diameter, 300 ft. high, with cores 500 or 600 ft. across and porous flanks are distinct from true reefs which form wave-resistant structure and are capable of growth into the zone of violent wave agitation. The core and host rock lack porosity and permeability but the latter is an ideal source rock. The porous flank facies makes an ideal trap for hydrocarbons. The thick lagoonal development provides the most favorable reservoir which will appear crescent-shaped in plan. Seismic work guided and assisted by sedimentary studies may possibly locate these attractive areas.--K. M. Willson.

2-987. Went, F. W. ORGANIC MATTER IN THE ATMOSPHERE, AND ITS POSSIBLE RELATION TO PETROLEUM FORMATION: Natl. Acad. Sci., Proc., v. 46, no. 2, p. 212-221, Feb. 1960, 12 refs.

It is shown that per year approximately $2 \times 10^8$ tons of volatile plant products are released into the air. In view of the lack of any mechanism by which these volatile products (predominantly terpenes) can be oxidized to $CO_2$ and $H_2O$, and in view of the fate of gasoline vapors in the air of cities, and based on direct experiments, it is shown that these volatile plant products become particularized in the atmosphere. This condensation process is dependent upon sunlight and partly upon the presence of nitrogen oxides.

This condensation leads to the "heat" or "summer haze" formation present over all vegetated areas. Ultimately the haze particles become precipitated on the earth by rain and snow. It is suggested that this material, bituminous or asphaltic in nature, is a source material for petroleum formation. Also many meterological facts are explainable on the basis of hazes derived from land plants.--Auth. summ.

2-988. Anderson, Eugene Carter. CARBON DIOXIDE IN NEW MEXICO (1959): New Mexico, Bur. Mines & Mineral Resources, Circ. 43, 13 p., 11 illus., map, 1959.

Underground reserves of carbon dioxide gas were discovered in New Mexico in 1916, but commercial exploitation of the gas was not attempted until 1934. Discoveries of carbon dioxide gas have been made in Colfax, Harding, Mora, Torrance, and Union counties, the largest known reserves being held in the

Bueyeros fields of Harding County. The origin of the gas is suggested to be from the calcining of limestone heated by igneous activity or emanating directly from igneous bodies. Reservoir pressures vary from 10 to 600 p.s.i., and the producing fields contain approximately 99% pure carbon dioxide gas.

At present 2 companies are packaging carbon dioxide, both in the liquid and solid states. The combined capacity of the 2 plants is 178 tons per day. Although the processing plants are small, very rugged and elaborate equipment is needed to withstand the high pressures and low temperatures required to transform the carbon dioxide gas into liquid or solid form.--G. B. Griswold.

**2-989. Patterson, W.H. OIL, GAS ACCUMULATIONS IN ARCTIC A GOOD BET: Oilweek, v. 10, no. 44, p. 14-18, Dec. 18, 1959.**

Seepages of oil on Melville Island have been reported. Shale on this island has been burned for fuel. Geological conditions make it reasonable to expect valuable accumulations of oil and gas in the Arctic. Some 40 piercement domes have been spotted in the region. Geological exploration in the Arctic Islands appears to be no great problem. The Geological Survey of Canada has carried out surface reconnaissance in all of the Arctic Islands.--Worldwide Oil & Gas Abstracts, v. 5, no. 1, p. 23, Jan.-Feb. 1960, abs. 51-8-17.

**2-990. Ingham, Albert I. OIL AND GAS FRONTIERS IN THE EAST: GeoTimes, v. 4, no. 6, p. 14-16, 33-34, illus., March 1960, 18 refs.**

The northeastern United States has numerous attractive oil and gas prospects although some involve areas in which geologic structure is difficult to interpret. The following areas are specifically cited: Cambro-Ordovician, Silurian, Devonian, and Mississippian-Pennsylvanian of the Appalachian Plateau; the Ridge and Valley province; and the Atlantic Coastal Plain province. Exploration costs can be high. Geologists should work closely with their fellows engaged in exploration and development to attain optimum efficiency of effort.--M. Russell.

**2-991. Brundage, Harrison T. MANY OPERATORS ENTERING APPALACHIAN BASIN: World Oil, v. 150, no. 3, p. 93-99, port., map, sec., 2 tables, March 1960, 9 refs.**

In this area of stable and favored prices many fields have been missed by other plays and deeper horizons were ignored. Lately some fields of outstanding significance have been found, such as Rose Hill E. of the Appalachian front in Virginia, Harvey Lake in eastern Pennsylvania, the small oil production in Claiborne County, Tennessee, and Greensburg Field in Kentucky. Exploration faces difficulties of assembling blocks, "townlot drilling" problems and the older techniques, also masses of confusing and often erroneous data. There is much structure present, but stratigraphy is of controlling importance. Low volume, slow pay out, jumbled information, and other problems are present when production is found.--K. M. Willson.

**2-992. Bieberman, Robert A., Roy W. Foster, and Joann K. Huenergardt. PETROLEUM DEVELOPMENTS IN NEW MEXICO DURING 1958: New Mexico, Bur. Mines & Mineral Resources, Circ. 52, 103 p., 15 maps, 2 graphs, 1960.**

Crude oil and distillate production in New Mexico amounted to 98,514,926 barrels in 1958, an increase of 3,887,121 barrels over 1957. The production of natural gas declined from 728,645,000,000 cu. ft. in 1957 to 726,236,763,000 cu. ft. in 1958. New Mexico ranks seventh in oil and fourth in natural gas production in the United States.

A total of 1,819 wells were drilled during the year, a decrease of 408 from 1957. Drilling activity in the nonproducing counties increased from 15 wells in 1957 to 22 wells in 1958.

A discussion of developments in New Mexico during 1958 is included, together with maps showing the location of new discoveries. Subsurface completion data are given for the 1,819 wells drilled for oil and gas during 1958.--Auth.

**2-993. Brown, Beverly L. LIST OF OIL AND GAS TESTS IN SOUTH DAKOTA: South Dakota, State Geol. Survey, Circ. 30, 18 p., Apr. 1959.**

A list of the 348 oil and gas tests made in South Dakota up to Apr. 15, 1959 is given both alphabetically by name of well and by county. The well locations are given by section, township, and range. --M. J. Tipton.

**2-994. Troutman, Arthur, ed. THE DEEP EDWARDS TREND IN SOUTH TEXAS: [115] p., maps, secs., logs, diags., Austin, Texas, Oil Frontiers Pub. Co., [1958], refs.**

A manual of field data and essential facts on the deep Edwards [Lower Cretaceous] trend in S. Texas. For each of 24 fields in the Edwards Lime in the counties of Atascosa, LaSalle, Live Oak, McMullen, and Webb, there is given the following information: location, discovery well, productive zone, principal operator, number of Edwards Lime producing wells, production data, and a location map. Eight papers on various aspects of oil development in the Edwards Lime area are listed below. They are abstracted separately in the order in which they appear in the manual.--M. Russell.

Biggs, W. P. LOGGING THE DEEP EDWARDS, 5 p.

Moore, W. Lee GEOPHYSICS ALONG THE EDWARDS TREND, 11 p.

Dassow, Durward W. PRODUCTION AND DRILLING TECHNIQUES AND COSTS FOR DEEP EDWARDS LIMESTONE IN McMULLEN AND LaSALLE COUNTIES OF SOUTHWEST TEXAS, 6 p.

Knebel, Robert M. PRELIMINARY NOTE ON THE FASHING (EDWARDS LIME) FIELD, 7 p.

Knebel, Robert M., and Franklin C. Jones. EDWARDS LIMESTONE FIELDS OF ATASCOSA COUNTY, TEXAS, 11 p.

Kimmell, Charles E. EDWARDS LIMESTONE EXPLORATION IN WEBB, LaSALLE, McMULLEN AND LIVE OAK COUNTIES, TEXAS, 6 p.

Zink, Edman R. RESUME OF THE LOWER CRETACEOUS OF SOUTH TEXAS, 12 p.

Hendy, William J. LOWER CRETACEOUS (EDWARDS) OIL FIELDS, CALDWELL & GUADALUPE COUNTIES, TEXAS, 16 p.

**2-995. Biggs, W. P. LOGGING THE DEEP EDWARDS (In: Troutman, Arthur, ed. The Deep Edwards Trend in South Texas: 5 p., 3 logs, Austin, Texas, Oil Frontiers, [1958])**

Thin beds and invasion conditions in the Edwards limestone [Lower Cretaceous], hamper electrical surveying; however the (Schlumberger) induction-electrical survey gives excellent values of formation resistivity. The sonic log is a reliable device for porosity determination.--M. Russell.

2-996. Moore, W. Lee. GEOPHYSICS ALONG THE EDWARDS TREND (In: Troutman, Arthur, ed. The Deep Edwards Trend in South Texas: 11 p., 2 maps, 2 secs., 6 logs, Austin, Texas, Oil Frontiers, [1958]) reprinted from: Gulf Coast Assoc. Geol. Soc., Trans., v. 7, p. 55-64, 1957.

Since the discovery of the Luling Field, Caldwell County, Texas, in 1922, geophysics has contributed toward the successful development of the Edwards trend in S. Texas. Sample gravity data, typical reflection records, and a cross section of a faulted zone in the Edwards illustrate the effectiveness of a geophysical program toward the common goal of both the geologist and the geophysicist - to find more petroleum reserves.--Auth.

2-997. Dassow, Duward W. PRODUCTION AND DRILLING TECHNIQUES AND COSTS FOR DEEP EDWARDS LIMESTONE IN McMULLEN AND LaSALLE COUNTIES OF SOUTHWEST TEXAS (In: Troutman, Arthur, ed. The Deep Edwards Trend in South Texas: 6 p., map, Austin, Texas, Oil Frontiers, [1958]) reprinted from: Gulf Coast Assoc. Geol. Soc., Trans., v. 7, p. 51-53, 1957.

The area discussed in this paper extends from southwestern La Salle county through N.-central McMullen County, Texas.

Several drilling procedures are used, but one suggested here is: drill to the top of the Edwards and core at least 35 ft. of porosity, then open hole drill-stem test and if test is successful, drill at least 200 ft., set pipe and do any further testing through production string. Costs range from $100,000 to $130,000 for a dry hole and from $180,000 to $230,000 for a completed well. Both power and steam rigs have been used for drilling with approximately the same price. Surface casing requirements are from 1,000 to 5,000 ft. surface, protection string only around salt domes, N-80 17 lb. 5 1/2" casing on bottom 4,000 ft., and plastic coated tubing.

Electrical logs suggested are: the Neutron or 37 1/2 in. Limestone Lateral for porosity. Induction log for resistivity and SP Curve. Microlog or contact log to indicate wall cake thickness and hole size. Mud program suggested is diesel emulsion at the top of Midway shale. Mud weights of 11.1 to 11.5 to be used when topping Edwards. A new surfactant type mud is being used to cut mud solidification. Mud solidification is due to high bottom hole temperatures. Lime base mud can be used in the Tilden area when no Kiamichi is expected. High bottom hole temperatures may be causing completion equipment failure.

Acid program recommended is 10,000 gals. of regular limestone acid with 500 to 1,000 gals. mud acid followed by some surface tension reducing agent. Edwards will take acid at 4,200 lb. pressure.

Reservoir conditions are 10% porosity, recovery 700 to 900 MCF per acre foot, plus 10 to 15 barrels condensate per MMCF. Well head pressure is approximately 5,300 lb. All gas here has hydrogen sulfide. Production tests indicate that any water produced initially will disappear after testing. Tests and sale of gas for drilling indicate that wells clean very slowly and pressures are higher after some production. Gas is being contracted for 14 cents per thousand with considerable interest from transmission companies. Production procedures and drilling techniques are in the experimental stage.--Auth.

2-998. Knebel, Robert M. PRELIMINARY NOTE ON THE FASHING (EDWARDS LIME) FIELD, ATASCOSA COUNTY, TEXAS (In: Troutman, Arthur, ed. The Deep Edwards Trend in South Texas: 7 p., 3 maps, sec., log, Austin, Texas, Oil Frontiers, [1958]) reprinted from: Gulf Coast Assoc. Geol. Soc., Trans., v. 6, p. 117-122, [1956].

Where the fault is the primary sealing factor, production from one bed along this fault is indirect evidence of closures on the other beds, both shallower and deeper. The microlog of the Edwards lime in the discovery well optimistically recorded as equal in importance both effective and ineffective porosity. According to the seismograph work, the throw of the fault near the discovery well was some 800 ft. This interpretation places the Edwards on the upthrown side against the Austin-Georgetown section on the downthrown side of the fault. It would then seem that a displacement sufficiently great to move Edwards against Taylor shale is not prerequisite for Edwards production.--Auth. concl.

2-999. Knebel, Robert M., and Franklin C. Jones. EDWARDS LIMESTONE FIELDS OF ATASCOSA COUNTY, TEXAS (In: Troutman, Arthur, ed. The Deep Edwards Trend in South Texas: 11 p., 8 maps, sec., Austin, Texas, Oil Frontiers, [1958]) reprinted from: Gulf Coast Assoc. Geol. Soc., Trans., v. 7, p. 35-44, 1957.

Each of the known Edwards limestone fields of Atascosa County, Texas, produces from the upthrown block of an up-to-the-SE. fault. All the fields are similar structurally; one, Pleasanton, a typical Edwards field, is discussed in detail.-- From auth. introd.

2-1000. Kimmell, Charles E. EDWARDS LIMESTONE EXPLORATION IN WEBB, LaSALLE, McMULLEN AND LIVE OAK COUNTIES, TEXAS (In: Troutman, Arthur, ed. The Deep Edwards Trend in South Texas: 6 p., 2 maps, sec., Austin, Texas, Oil Frontiers, [1958]) reprinted from: Gulf Coast Assoc. Geol. Soc., Trans., v. 7, p. 45-49, 1957.

Exploration of the deep middle Cretaceous limestones in SW. Texas has been carried on at a fast pace since the first gas discovery in 1953 by the Humble Oil and Refining Company, of the San Miguel-Edwards Field. This discovery and development of an entirely new trend of production was preceded by a number of interesting dry holes, the first of which was drilled in 1940. The presently known reservoirs are associated with salt domes, biostromal reefs, regional flexures, and local faults.--Auth.

2-1001. Zink, Edman R. RESUME OF THE LOWER CRETACEOUS OF SOUTH TEXAS (In: Troutman, Arthur, ed. The Deep Edwards Trend in South Texas: 12 p., 3 maps, chart, 2 secs., Austin, Texas, Oil Frontiers, [1958]) reprinted from: Gulf Coast Assoc. Geol. Soc., Trans., v. 7, p. 13-22, 1957.

The Lower Cretaceous of S. Texas is present in 3 prominent geologic provinces: the Rio Grande embayment, the San Marcos arch, and a part of the westernmost flank of the E. Texas embayment. The lithologies of the correlative lower Cretaceous rock units show definite basinal characteristics flankward and an increase in thickness from the San Marcos arch into the E. Texas and Rio Grande embayments. The regional structure is generally that of a monocline dipping S. and E. away from the central Texas, Edward plateau, and Llano uplift provinces. The top of the Georgetown (Lower Cretaceous) formation, shows southerly dip at the rates of 150 ft. to the mi. in the Rio Grande embayment area, and 300 ft. to the mi. over the San Marcos arch area and its eastern flank. This monocline is bounded on the N. and W. by the Balcones fault system and is locally broken by the Luling, Charlotte, and Mexia fault systems, each of which are not confined to any particular province. The San Marcos arch, and the Rio Grande and E. Texas embayment areas are traversed by the NE. and ENE. arcuate trending fault systems. The bulk of the lower Cretaceous oil production is from up-to-the-SE.-fault block structures along the Luling and Charlotte fault systems.--Auth.

2-1002. Hendy, William J. **LOWER CRETACEOUS (EDWARDS) OIL FIELDS, CALDWELL & GUADALUPE COUNTIES, TEXAS** (In: Troutman, Arthur, ed. The Deep Edwards Trend in South Texas: 16 p., 3 maps, log, Austin, Texas, Oil Frontiers, [1958]) reprinted from: Gulf Coast Assoc. Geol. Soc., Trans., v. 7, p. 23-34, 1957.

Since the discovery of oil in the Lower Cretaceous Edwards formation near Luling, Caldwell County, Texas, in Aug. 1922, about 234,000,000 barrels of oil have been produced from 5 fields, with 2 fields accounting for about 200,000,000 barrels. Although shows have been encountered in the Edwards formation in Travis, Bastrop, Lee, Milam, Bexar, Wilson, and Gonzales counties, commercial production has been limited to an area near the crest of the San Marcos arch in Caldwell and Guadalupe counties, Texas. Closure against up-toward-the-coast faults forms the traps for the fields. These faults were all located by surface geology. A small amount of production has been obtained from the Buda formation of Lower Cretaceous Washita age, which is unconformable beneath the Upper Cretaceous Eagleford formation. At present, no production has been established in beds older than the Edwards formation in S.-central Texas.--Auth.

2-1003. Hager, Dilworth S., and Claude M. Burnett. **MEXIA-TALCO FAULT LINE IN HOPKINS AND DELTA COUNTIES, TEXAS**: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 3, pt. 1, p. 316-356, 9 maps, sec., March 1960, 11 refs.

Reconnaissance mapping for petroleum exploration began in the early 1920's along the Mexia-Talco fault line in Hopkins County, Texas. Drilling to test the Woodbine sand, which took place largely between 1925 and 1933, has thus far been unsuccessful. Since the discovery in 1936 of the Sulphur Bluff field, subsequent Paluxy testing resulted in the discovery of Mitchell Creek field in 1948 and the small Birthright field in 1954. In 1958, production from the Smackover limestone of Jurassic age was established on the Sulphur Bluff fault. These fields are located on en echelon faults, each of which has a corresponding back fault, resulting in a series of grabens.

Most of the wells along the fault line in western Hopkins County and Delta County have been drilled since 1940, and in nearly all instances, electric logs were run. Because of the availability of electric logs, more accurate interpretation of the geologic history of the W. area is possible than in the E. half of Hopkins County.

The area has a flat to rolling topography. It is drained on the N. by Sulphur River and on the S. by the tributaries of White Oak Bayou and Caney Creek. Along Sulphur River in the extreme western part of Hopkins County and in Delta County, much of the land is very flat and covered with secondary material.

Jurassic, Cretaceous, and Tertiary sediments have been penetrated by the drill in this area, making possible relatively detailed lithologic descriptions and interval measurement. Careful comparisons of the intervals and sections show their relative thickening and thinning and reveal the timing of the faulting. These comparisons show that there were movements along the faults from early Cretaceous time. However, these movements were not continuous, but were interrupted by periods of quiescence when little or no movement took place.

The surface map shows the front faults, back faults, and graben areas in the E. half of Hopkins County. For convenience in mapping the surface faults, the Midway formation has been divided into 3 parts in this paper, instead of the customary 2. In Delta and extreme western Hopkins counties, the Peerless fault is mapped on surface outcrops and the upthrown structure contoured on the top of the caprock of the Nacatoch sand.

The front faults and complementary back faults forming the grabens are also shown on Pecan Gap structural maps and Goodland structural maps for both the E. and W. parts of Hopkins County and southern Delta County. The text explains how these maps were made and points out salient features and differences.

The grabens are contoured where subsurface control is available on the Pecan Gap maps. In the Sulphur Bluff field the downthrown beds are complexly folded into several small irregular highs and lows. The Goodland map on identical areas, but on the upthrown side of the fault, shows a long regular structure. A comparison of the structural highs on the Sulphur Bluff and Hatchetville faults shows that there was pronounced uplift from early Cretaceous time at Sulphur Bluff, while the area at Hatchetville appears to have been structurally low for a long period. This accounts for the large accumulation of oil in the Sulphur Bluff field.

A cross section extending N. and S. across the Sulphur Bluff field graphically shows the front and back faults with their accompanying grabens.

The present small highs on the Posey and Peerless faults in the western half of the county actually decrease with depth. This accounts for the absence of oil from the Paluxy formation in the western half of the county.

The long period of quiescence along the entire fault zone in northern Hopkins and Delta counties after basal Austin chalk time probably accounts for the absence of any oil or gas accumulations in the Woodbine and sub-Clarksville sands on the upthrown side of the S. front faults.

Future oil possibilities from new sands are not overly favorable at this time. However, Woodbine accumulations in the graben areas are a definite possibility.

The Preston syncline in western Hopkins and Delta counties appears to be due to fairly late sinking. From Fredericksburg to Pecan Gap time, this syncline was shallow and at times possibly nonexistent.--Auth.

2-1004. Kornfeld, Joseph A. **COTTON VALLEY DISCOVERIES SPUR DEEP PAY SEARCH IN EAST**

XAS BASIN: World Oil, v. 150, no. 3, p. 69-71, rt., map, table, March 1960, 2 refs.

Jurassic production has been found in Linden field Cass County, Waskom field in Harrison County and uitvale in Van Zandt County. At Fruitvale there is ensification of structure as the Austin (Cretaceous) ows 100 ft. of closure while the Cotton Valley rmation (Jurassic) shows 600 ft. Salt intrusion, ncation, and faulting lend complications to these mes. There are probably a number of other milar favorable structures in the basin.--K. M. llson.

1005. Harris, Herbert I., and William D. Mott. STRALIA'S OIL HUNT IN THE GREAT ARTESIAN BASIN: World Petroleum, v. 31, no. 1, p. 40-42, 63, Jan. 1960.

The Artesian Basin occupies more than 600,000 sq. mi. of the inland of eastern Australia. The Mesozoic sediments in this basin of gentle downwarp, have suffered only slight deformation into broad anticlines and synclines with minor faulting. At Roma, gas and oil have been found in several wells just above basement. At Longreach a show of gas was found in a bore which cut the pinchout of Jurassic beds against a buried granite ridge. An Australian concession map is included.--Worldwide Oil & Gas Abstracts, v. 5, no. 1, p. 24, Jan.-Feb. 1960, abs. 51-8-32.

## 14. ENGINEERING GEOLOGY

e also: Geophysics 2-901; Geohydrology 2-952.

1006. Stefanko, Robert. ROCK MECHANICS - D TO STRATA CONTROL: Mineral Industries, 29, no. 2, p. 4-7, 3 illus., 2 diags., Nov. 1959, refs.

There is no aspect of mining that has a greater fluence on productivity than ground control. A owledge of stress conditions in the mine strata is sential to the establishment of optimum mining ans and the application of artificial supports as fective counter-measures.

Limitations of laboratory analyses and techniques ve created a need for a direct observation of the anges in the stress equilibrium of a mine structure ith mining activity. In experiments conducted at e mine, strain gage techniques were first utilized, nce they provided the greatest accuracy consistent ith economy. However, instrumentation of artifi- al supports failed to produce the desired results, ecause too many variables were introduced with the chniques. Subsequently, stressmeters 4 in. long ith a 1 1/2-in. diameter and consisting of an inter- l disc equipped with a strain rosette were cemented to holes drilled into the mine stratum. The meas- ed results correlated well with mining activity and dicated a need for modification of the existing ining system.

Instrumentation techniques indicated the inability roof bolts to provide adequate support in this mine e to the soft stratum which prevailed at the depth anchorage. Stressmeters were far superior for easuring structural stress changes. Not to be erlooked are other alternate stress-measuring chniques. Among the most important of these are sonic methods, although the technique utilizing anges of electrical resistivity with rock pressure ows possibility. Considerable effort must be pended to develop these techniques to their full tential and the Dept. of Mining at Pennsylvania ate University is contributing to this goal through panding research.--Auth.

1007. Jumikis, Alfreds R., W.W. Holman, and R. Schuyler. THE ENGINEERING SOIL SURVEY D ITS RELATION TO ENGINEERING PROBLEMS : Soil and Materials Surveys by Use of Aerial otographs: Natl. Research Council, Highway Re- arch Board, Bull. 213 (Natl. Acad. Sci.-Natl. Re- arch Council, Pub. 666), p. 1-11, 2 maps, 2 arts, table, 1959) 3 refs.

This article describes the engineering soil survey [in New Jersey] and the research techniques and methods which were applied in the preparation of the engineering soil maps. Each of the 21 New Jersey county reports presents detailed information concerning the various soil areas which are delineated on the engineering soil map. The symbols shown on these maps are explained, engineering test values are given for the major soil types, and comments are presented relative to each type of material. This article also illustrates some of the applications to various engineering problems.

The soil survey work was greatly facilitated by the use and interpretation of aerial photographs. The photographs were of particular value in mapping soil types in mountainous areas, as well as in the coastal plain province. --Auth.

2-1008. Deen, R.C. AN ENGINEERING SOIL SURVEY OF FAYETTE COUNTY, KENTUCKY (In: Soil and Materials Surveys by Use of Aerial Photographs: Natl. Research Council, Highway Research Board, Bull. 213 (Natl. Acad. Sci.-Natl. Research Council, Pub. 666), p. 12-28, 2 maps, 4 secs., 2 tables, 1959) 5 refs.

Agricultural soil scientists have developed a system of soil classification and mapping that has been and is continuing to be of great value to the soils engineer in reconnaissance and mapping. This report covers a statistical method of correlation used in a pilot study conducted in order to make engineering soils data available from a pedological map of Fayette County.

Assuming that the reliability of pedological classifications holds true for engineering properties, the engineering test constants for a given horizon of a given soil should fall within a narrow range, and the limits of this range should be reasonably determinable from the results of tests on a small number of random samples. In the present study a range with a confidence coefficient of 0.90 was determined by the statistical method used.--Auth.

A brief discussion by James H. McLerran is included at the end of the article.

2-1009. Stoeckeler, E.G., and W.R. Gorrill. AIRPHOTO ANALYSIS OF TERRAIN FOR HIGHWAY LOCATION STUDIES IN MAINE (In: Soil and Materials Surveys by Use of Aerial Photographs: Natl. Research Council, Highway Research Board, Bull. 213 (Natl. Acad. Sci.-Natl. Research Council, Pub. 666), p. 29-43, 5 illus., 2 maps, profile, 10 stereograms, table, 1959) 5 refs.

Aerial photographs have been used in Maine in the following types of highway location studies: a) preliminary cost estimates for portions of the interstate system, b) detailed study of proposed route locations, and c) relocation studies for secondary roads. The interstate route studies included soils, rock excavation, gravel sources and haul distance, and drainage conditions; changes in P-line were made to avoid peat or muck. The detailed study of a proposed route included the preparation of large scale engineering-soil strip-maps. The relocation studies for secondary roads included information regarding soils, gravel sources, and drainage.--Auth.

2-1010. Livingstone, F.C. **MONT BLANC TUNNEL: Military Engineer, v. 51, no. 344, p. 487-488, 4 illus., map, diag., Nov.-Dec. 1959.**

A 7-mi. vehicular tunnel with an excavation section of 861 ft. is being driven through Mont Blanc from Entrèves in Italy to Chamonix in France. The tunnel will range from 4,179 ft. above sea level at Entrèves to 4,583 ft. at the meeting of the French and Italian sections within the tunnel. The first 3,000 to 5,000 ft. of tunneling at Entrèves will be through calcareous schist after which solid granite is expected. Engineering, ventilation, lighting, and administrative aspects of the tunnel are described.--M. Russell.

2-1011. Kachadoorian, Reuben. **ENGINEERING GEOLOGY BEARING ON HARBOR SITE SELECTION ALONG THE GULF OF ALASKA FROM POINT WHITSHED TO CAPE YAKATAGA, ALASKA: U.S. Geol. Survey, Trace Elements Inv. Rept. 642, 32 p., illus., 7 maps (6 in pocket), graph, 2 tables, Dec. 1959, 5 refs.**

An analysis of the known geologic factors in the Point Whitshed-Cape Yakataga area, Alaska, indicates that the most suitable location for a harbor to be excavated by nuclear-device techniques is a section of coastline from Point Martin to the town of Katalla.

Three sites [were] selected in the Point Martin-Katalla area. Site 1 at Point Martin is underlain by terrace gravel overlying sedimentary rocks of Tertiary age. The site is protected from SE. storms but not from SW. storms. Longshore transport of sediments is to the W. during high tides and either lacking or to the E. during low tides. The 60-ft. offshore contour is within 1.5 mi. of the site and the 30-ft. offshore contour is within 0.4 mi.

Site 2 at Palm Point is underlain by beach gravel, terrace gravel, and muskeg deposits that overlie Tertiary sedimentary rocks. The site is protected from SW. storms but exposed to SE. storms, which are the major ones in the Point Whitshed-Cape Yakataga area. The beach at this site is being eroded actively and the sediments are carried offshore by waves that break at right angles to the beach. The 60-ft. offshore contour lies within 2 mi. of the site area; the 30-ft. offshore contour is within 0.3 mi.

Site 3 at the town of Katalla is underlain by beach and terrace deposits overlying Tertiary sedimentary rocks. This site offers better protection than either of the other 2 from SE. and SW. storms. Longshore transport along a spit E. of the site has filled the Katalla River channel to within 3 ft. of the surface to mean low tide. Dredging requirements at this site would be much greater than at sites 1 and 2. The 60-ft. offshore contour is within 3.5 mi. of Katalla and the 30-ft. contour within 1 mi.--Auth.

2-1012. U.S. Bureau of Reclamation. **TECHNICAL RECORD OF DESIGN AND CONSTRUCTION. KORTES DAM AND POWERPLANT, CONSTRUCTED 1946-1951: 294 p., 133 figs. incl. illus., maps, secs., diags., graphs, tables, Denver, Colorado, Dec. 1959, 23 refs.**

This technical record of design and construction of Kortes Dam and Powerplant, North Platte River, Wyoming, is divided into 4 main parts. Pt. 1 contains a discussion of general planning and historical information, a description, and a summary of costs. Pt. 2 is devoted to discussions on geology, and foundation treatment. Pt. 3 is devoted to discussions on the design of various structures. In this part the design of the dam, spillway, powerplant and switchyard, including the appurtenant equipment, is made the subject of a separate chapter. Pt. 4, Construction, comprises 8 chapters which discuss contract administration; surveys; excavation, concrete, and grouting operations; installation of power equipment; installation of control and station-service equipment; installation of switchyard components; installation of trashracks, gates, and penstocks; and installation of cranes and miscellaneous equipment.--From foreword.

Kortes Dam impounds water in Black Canyon, which cuts across and roughly bisects the Seminoe Mountains, the core or main mass of which is composed primarily of granite, granite gneiss, and hornblende schist, locally intruded by dolerite, pegmatite, and aplite dikes. The Precambrian core is about 18 mi. in length and ranges from 2 to 6 mi. in width. A variety of sedimentary rocks, ranging from earliest Paleozoic to youngest Tertiary, surround the Seminoe Mountains. Bedrock at Kortes Dam consists chiefly of a light-colored, medium-grained granite with variations ranging from coarse-grained pegmatitic to strongly gneissic phases. A thick dike of dark gray to black dolerite crosses the axis of the dam near crest elevation in the left abutment area. It was not of major practical importance in relation to the dam and did not materially weaken the left abutment. The entire rock mass of the abutments and foundation is severely jointed and fractured.--From Pt. 2, Chap. 2, p. 11.

2-1013. Martin, R. Torrence. **RHYTHMIC ICE BANDING IN SOIL (In: FROST EFFECTS IN SOILS AND ON PAVEMENT SURFACES: Natl. Research Council, Highway Research Board, Bull. 218, p. 11-23, 2 illus., 5 diags., table, 1959) 13 refs.**

A comprehensive theory to explain rhythmic ice banding, which produces frost heave in soil, is presented. For convenience in discussion the theory is divided into 4 stages which overlap and are interrelated. The stages are: 1) nucleation of ice at some distance from an existing ice front, 2) rapid growth of this nucleus into an ice lens, 3) termination of crystal growth, and 4) heat and water flow between the end of stage 3 and the beginning of a new cycle at stage 1. Consideration of all 4 stages is necessary to an understanding of frost heave.

The unsteady heat flow condition that exists in a freezing soil has an effect upon, and is effected by, nucleation and growth of ice crystals; this interrelationship produces rhythmic ice banding. Water transport through the soil and the accompanying latent heat of fusion are both an essential part of the net heat flow. The mechanism developed is completely analogous to the periodic precipitation of pure chemical systems. The behavior of such chemical sysems, called Liesegang phenomena, occur when 2 olutions, upon diffusing into one another, react to orm an insoluble product.

Utilizing the theory, it is possible to predict the istance between successive ice fronts; these preictions agree with experimental results.

For rhythmic banding to occur, the nucleation emperature just below the ice front must be lower ian the nucleation temperature at a somewhat reater distance from the ice front. Consolidation nd/or a lower degree of saturation below the ice ont, which lowers the nucleation temperature, are aused by the tension that develops in the water uring ice lens formation.

Soils that do not ordinarily heave (sands and lays) are treated as special cases of the proposed iechanism for which data on analogous Liesegang ystems are available. The heave of a clay at a ery low rate of freezing is also considered.

The theory is presented as a working hypothesis mbracing the entire process in a freezing soil and icluding all soil types.--Auth.

-1014. Pryer, R.W. **FROST ACTION AND RAIL-OAD MAINTENANCE IN THE LABRADOR PENIN-ULA (In: FROST EFFECTS IN SOILS AND ON PAVE-IENT SURFACES: Natl. Research Council, Highway esearch Board, Bull. 218, p. 34-48, 6 figs. incl. iap, 1959) 8 refs.**

Prior to 1950, engineering activity in the Labrador eninsula was confined to a few of the more accessile areas and was limited in scope. A full-scale emonstration of many of the engineering problems ssociated with this little-known region has been rovided by the Quebec North Shore and Labrador ailway, a 360-mi. railroad constructed between 950 and 1954 to serve the new Fe mining district in ie interior of the peninsula. Experience since 1954 as shown that the operating conditions imposed by rigorous winter climate, particularly the necessity carry a heavy tonnage during a relatively short hipping season, requires an unusually high standard f railroad maintenance.

This paper describes some of the manifestations f frost action which have proved troublesome from ie standpoint of railroad maintenance in the Labraor peninsula and also reports the results obtained om a number of ground temperature installations. he data show values recorded for frost penetration nder various conditions of exposure, including cut nd embankment sections of the railroad subgrade, ndisturbed snow and natural ground cover, an iceovered automobile parking lot, and an Fe ore stock ile.

On the basis of the ground temperature data it is oncluded that a snow-vegetative cover is one of the iore important variables controlling the depth of ost penetration. Removal or disturbance of these iedia permits deep penetration of frost (as much as or 7 ft.) in a snow-covered cut section and more ian 10 ft. in an exposed embankment.

A consideration of the physiography of the Labraor peninsula suggests that in the terrain traversed the Quebec North Shore and Labrador Railway, imate, ground-water conditions, vegetative cover, id the distribution of frost-susceptible soils are irly representative of conditions throughout much the region.--Auth.

-1015. Charles, J.L. **PERMAFROST ASPECTS F HUDSON BAY RAILROAD: Am. Soc. Civil ngineers, Soil Mech. & Found. Div., Jour., v. 85, no. SM6, pt. 1, p. 125-135, 2 maps, diag., sec., Dec. 1959.**

Based on observations during a period of nearly 50 years [1910-1959, Hudson Bay Railway, The Pas to Churchill, Manitoba], in railway location, construction, and maintenance in territory where permafrost occurs, the following general recommendations are submitted:

1) Before ground surveys are commenced to establish a location for a proposed railway, air photos should be used to indicate where and to what extent, permafrost may occur and to locate possible deposits of granular materials.

2) Air photographs and photogrammetry should also be used to aid in selection of the best route. Careful consideration of drainage features is important.

3) In territory where permafrost occurs in comparatively small isolated areas - "islands" - such areas should be avoided to the extent practicable in relation to distance and ruling gradients etc.

4) Permafrost on a side-hill slope can become very troublesome.

5) Where it is not practicable to avoid excavating in permafrost for construction of a railway roadway, excavations should be extended to a depth of 3 ft. to 5 ft. below sub-grade, then backfilled immediately with comparatively dry materials preferably granular if available.

6) Sides of cuts in permafrost should be excavated to very flat slopes, as a precaution against materials sliding and obstructing drainage ditches.

7) Drainage is especially important in areas of permafrost. Off-take ditches should be excavated and well maintained to prevent accumulation of water against side-slopes of embankments, particularly where they are built on permafrost, as water in contact with it will cause thawing.

8) Special care is necessary in selecting sites for bridges and culverts and type of structure with respect to site conditions. Whereas first class foundations are essential for rigid type structures, such as steel bridges on concrete sub-structures, it is not so serious if some distortion occurs in a timber trestle or a cedar box culvert; they will remain functional.

9) Cross section area of culverts should be comparatively large to facilitate cleaning in event of an accumulation of ice.

10) In areas where permafrost is general and there are no great changes in topography, such as the tundras, if practicable, design the location to obtain a roadway to be entirely embankment.

11) Relative telegraph and telephone lines should be erected on tripods of cedar poles, set on the surface.

Excavations should be restricted to off-take ditches and minor levelling on the railway right-of-way just sufficient to permit track to be laid. Then the track should be lifted by trainfill, to build up embankments on undisturbed permafrost.

When constructing where permafrost is general, preserve this condition, build on it, do not excavate into it, except for essential drainage to prevent accumulation of water and relative thawing.--From auth. concl.

2-1016. Péwé, Troy L., and Russell A. Paige. **FROST HEAVING OF PILES, WITH AN EXAMPLE FROM FAIRBANKS, ALASKA: U.S. Geol. Survey, Repts., Open-File Ser., [no. 506], 138 p., 16 illus.,** 4 maps (2 fold.), 6 secs. (5 fold.), fold. profile, 8 diags., 7 graphs, 6 tables, 1959, approx. 120 refs.

Seasonal freezing of the ground is common throughout most of the world's land surface. As the ground freezes the surface of the ground may rise - this rising is termed frost heaving. Upward displacement of the ground upon freezing is not due alone to the freezing of water originally contained in the soil voids, but is due mostly to the formation of clear-ice segregations in the sediments. Ice segregations form as water is drawn to points of freezing from adjacent unfrozen ground; the basic physical phenomenon which permits the growth of such segregations is that some water in the ground remains liquid although subjected to temperatures below $0^{\circ}C.$, and can therefore move to the growing ice segregations.

As the freezing isotherm descends through the ground, water is changed from liquid to solid. The amount of ice finally concentrated in the frozen ground, the size, shape, and position of the ice segregations, and therefore, the amount and location of frost heaving, depends upon many physical factors. The 2 most important factors are the temperature of the air and texture and moisture content of the ground. The most favorable conditions for growth of ice segregations and for frost heaving are slow freezing of moist, nonhomogeneous, organic silt or silty clay.

When ground is forced upward during seasonal freezing, engineering structures are also forced upward if the forces acting upward are greater than the forces pushing downward. With piles the amount of the upward force is dependent upon: 1) the amount of clear-ice segregations formed in the seasonally frozen ground, 2) the tangential adfreezing strength, or bond, between the surface of the pile and the seasonally frozen ground, and 3) the surface area of the pile in the seasonally frozen ground. The main factor opposing the upward force is the grip of the ground on that part of the pile which lies below the seasonal frost. This grip may be either the "skin friction" of unfrozen ground or the tangential adfreezing strength between perennially frozen ground (permafrost) and the pile surface. The grip of permafrost can successfully counteract the effect of frost heaving on piling if the full tangential adfreezing strength of permafrost is attained over a large enough surface area of the pile. The tangential adfreezing strength of frozen ground varies with texture of the sediment, moisture content, temperature of the ground, and nature of the pile surface. It is strongest in ice-saturated fine sand and silt. The colder the ground the greater the adfreezing strength.

Piling of many of the wood-pile bridges of the Alaska Railroad in Goldstream Valley near Fairbanks, Alaska, are frost heaved every year. Many bridges in this poorly-drained, silt-filled valley are thrown out of line and the elevation of the track is seriously disturbed. Sharp humps that form in short bridges usually necessitate reduction of speed of the trains to avoid uncoupling of the cars or shifting of cargo. Piling of the bridges is frost heaved as much as 14 in. per year.

The engineering geology problems of frost heaving of bridge piling are of economic importance because of the maintenance necessary to: 1) maintain track elevation in winter by temporary methods, 2) correct the elevation in summer by more permanent methods, and 3) replace bridge piles periodically.

Three wood-pile bridges of the Alaska Railroad at mile posts 456.7, 458.4, and 460.4, respectively, were systematically observed for the effect of frost heaving of piling. Data were collected on moisture content and the position, thickness, and temperature of seasonal frost and permafrost at these localities. Studies of these bridges serve well to illustrate principles of the mechanics of frost heaving of piling as well as to show the position and properties of permafrost that are concerned with such principles.

Some of the piles in the first 2 bridges are not inserted deep enough into the permafrost to prevent the pile from pushing upward and deforming the bridge. Piling in bridge 460.4 is not subject to frost heaving because of 1) absence of frost heaving of piles in the stream bed, and 2) the low moisture content of the ground around the other piles.--Auth.

**2-1017.** Merriam, Richard H. **PORTUGUESE BEND LANDSLIDE, PALOS VERDES HILLS, CALIFORNIA:** Jour. Geology, v. 68, no. 2, p. 140-153, 3 illus., 6 maps, 2 secs., graph, March 1960, 9 refs.

In the Palos Verdes Hills an ancient complex landslide affects several hundred acres of seaward-dipping tuffaceous Miocene shales. In 1956 about 1/4 of the area of this slide began moving again along 6 to 7° slope by earthflow and shifting of large blocks. Movement is continuing at a rate which increases in the winter and decreases in the summer and ranges from 0.03 to 0.1 ft. per day.

Information derived from studies aimed at stabilization include data from 62 drill holes, survey records of horizontal and vertical movements, and results of soil tests.

Possible causes of the present movement suggested by various investigators are 1) loading of landslide head by highway fill and 2) accumulation of excessive ground water derived from cesspools, surface watering, and natural precipitation.

Attempts to control sliding by placing 25 4-ft.-diameter caissons 20 ft. long across the rupture surface were unsuccessful. A plan to accomplish stabilization by removing material from the head and placing it as a rock-protected earth fill at the toe is under consideration.

Damage to roads, houses, and other structures is estimated at more than ten million dollars.--Auth.

**2-1018. EARTHQUAKE DAMAGE REPAIR IN MONTANA:** Military Engineer, v. 51, no. 344, p. 466-467, 6 illus., Nov.-Dec. 1959.

As soon as the earthquake of Aug. 17, 1959, in southwestern Montana was over, it was evident that 2 major emergency repairs were necessary - the cu ting of a by-pass road to permit evacuation of 50 carloads of survivors trapped when 4 sections of road slid into Hebgen Lake, and the construction and maintenance of a channel and spillway through the Madison River landslide to prevent a runaway washout of the slide-dammed Madison River. A contractor working 35 mi. from the area was called and dozed 2 mi. of road in about 10 hours. Channeling of the landslide area called for the removal of 200,000 yds. of material to cut a spillway 16 ft. deep and 150 ft. wide on a 7% slope.--M. Russell.

# 15. MISCELLANEOUS

1019. **Finch, Vernor C., Glenn T. Trewartha,**
l M.H. Shearer. THE EARTH AND ITS RE-
URCES. A Textbook for Courses in Physical Ge-
raphy and Earth Science: 3d ed., 584 p., 463 figs.
l. illus., maps (8 col.), secs., diags., tables,
w York, McGraw-Hill, 1959, refs.

It is the purpose of this book to present the basic
ts concerning the earth as the home of man so that
student may realize their importance and under-
nd their relationship to the problems of his own
ne and place. To this end the major features of
physical earth are considered primarily as
parate topics and secondarily in connection with
different regions of the earth. These features of
environment are discussed under the following
in headings: 1) the atmosphere - weather and
mate; 2) landforms - plains, plateaus, hill country,
l mountains; 3) the oceans and their shores; 4)
rth resources - waters, vegetation, soils and
nerals. This treatment is supplemented by an
alysis of the various types of regions, for example,
matic regions and landform regions. The ele-
ents of the environment are further considered in
eir regional combinations and are viewed in the
ht of their value for man's economic and social
e.

Serious effort has been made to keep both the
ntent of the book and its language and vocabulary
a level that will be understandable to the begin-
g student in a subject which may be, and often is,
eated in a highly technical manner. Technical
ms are used sparingly and, when they are em-
yed, are carefully explained. More than 450
ps, diagrams, and photographs in black and white
l 15 pages of full color maps have been included
illustrate the text material and to assist the stu-
nt in visualizing the phenomena of the physical
vironment.

A laboratory manual has been prepared to accom-
ny this textbook [not seen].--From auth. pref.

Contents:
e Earth and Its Planetary Relations
mperature of the Atmosphere
mospheric Pressure and Winds
mospheric Moisture and Precipitation
rms and Their Weather Types
mates of the Tropics and the Dry Middle Latitudes
mates of Middle and High Latitudes
mposition and Changes of the Earth's Crust
aring Away and Building Up of the Land
ver-Made Plains
aciated Plains
teaus and Hill Country
untains
eans and Their Shores
ter Resources of the Land
tive Vegetation and Animal Life
ls
neral Fuels, Ores, and Other Economic Minerals
jor Regions and Resources of the United States
Appendix:
e Seasons
pplementary Climatic Data
teorological Instruments and the Weather Map
rth History
arning to Use Maps
: Topographic Quadrangles
cks and Minerals
eful Data and Tables

020. **Halliday, William R.** ADVENTURE IS
DERGROUND; THE STORY OF THE GREAT
CAVES OF THE WEST AND THE MEN WHO EXPLORE THEM: 206 p., 63 illus., 7 maps, sec., New York, Harper & Brothers, 1959.

This book deals with the discovery and exploratio of the great caves of western United States. It includes factual records of original discovery and exploration as well as legends and erroneous beliefs about them. A chapter on the techniques of cave exploring is included. The caves to which major attention is devoted are: Cave of the Winding Stair, Providence Mountains, California; Soldiers Cave, Sequoia National Park, California; Cavern of Gold, Kokoweef Peak, California; Crystal Cave, California; White Lace Cave, California; Arnold Ice Cave, Oregon; Quarry Cave, California; Devil's Hole, Nevada; Neff Canyon Cave, Utah; Clinton's Cave, Utah; Manitou Grand Caverns, Colorado; Spanish Cave, Colorado; Carlsbad Cavern, New Mexico; Cave of the Catacombs, California; and Moaning Cave, California. An annotated list of 30 commercial caves is included.--M. Russell.

2-1021. **Jillson, Willard Rouse.** A TOUR DOWN STREAM. NOTES ON THE TOPOGRAPHY, GEOLOGY AND HISTORY OF AN AREA BORDERING THE CUMBERLAND RIVER IN SOUTHERN KENTUCKY: 91 p., 11 illus., 5 maps, 9 secs., Frankfort, Kentucky, Perry Publishing Co., 1959, approx. 42 refs.

These are notes made during and subsequent to a 51.5 mi. trip by boat in Aug. 1951 from a point three quarters of a mile SW. of Creelsboro on the line between Russell and Clinton counties to Black's Ferry, just within the eastern bounds of Monroe County. The purpose was to observe the varying surface features of the land, the geology and oil possibilities of central Cumberland County and adjacent areas. A listing of fossils to be found at the outcrops is included in the locality descriptions.--M. Russell.

2-1022. **King, Ruth Reece, and others.** BIBLIOGRAPHY OF NORTH AMERICAN GEOLOGY, 1957: U.S. Geol. Survey, Bull. 1095, 531 p., 1960.

The current volume lists some 4,500 publications that appeared during 1957 dealing with the North American continent, Greenland, the West Indies, and other adjacent islands, Hawaii, Guam, and other island possessions, but not the trust territories of the United States. A few articles published before 1957, but not included in previous volumes, are cited also. Articles by American authors published in foreign journals are cited if they deal with North American localities or are of a general nature, but not if they deal with foreign areas. Articles by foreign authors on North America are included regardless of place of publication; those of a general nature are included if they appeared in North American journals.

Publications are listed alphabetically by author, with full title and other bibliographical information. Following the bibliography is a detailed subject index. --From auth. introd.

2-1023. **Canada, Geological Survey.** HELICOPTER OPERATIONS OF THE GEOLOGICAL SURVEY OF CANADA: Its: Bull. 54, 60 p., 12 illus. on 7 pls., 3 maps, 2 diags., 9 tables, 1959, 22 refs.; abs. in English and French.

This report describes the use of helicopters by the Survey as an aid to geological mapping and gives the operational and cost data for helicopter-supported parties in several areas of Canada under widely varying conditions. The advantages and disadvantages of various methods of operation are set forth.--Auth.

Contents:

Introduction, p. 1-6.
Light helicopter reconnaissance in the barren grounds, Northwest Territories (Operations Keewatin, Baker, Thelon), p. 7-14.
Light helicopter reconnaissance in New Quebec (Operation Fort George), p. 15-19.
Light helicopter reconnaissance in interior plains and mountains (Operation Mackenzie), p. 21-32.
Light helicopter mapping on a plateau, Cape Breton Island, p. 33-35.
Light helicopter mapping in Coast Mountains, British Columbia, p. 37-41.
Light helicopter mapping in mountainous regions (Operation Stikine), p. 43-53.
Heavy helicopter reconnaissance in the Arctic Archipelago (Operation Franklin), p. 55-60.

**2-1024.** [New York State Museum and Science Service, Geological Survey]. **GEOLOGICAL RESEARCH IN NEW YORK STATE, 1959: Its: Newsletter no. 11, 14 p., 2 maps, Feb. 1960.**

Individual geologic projects undertaken or continued during 1959 in New York are grouped under various headings alphabetically by name of the research worker. Under Precambrian geology, 18 are noted; under general geology including paleontology and stratigraphy, 37; under glacial geology, 4; under economic geology, 20; and under geophysics and geochemistry, 7. Three New York State Museum publications of geological interest and 26 publications on New York geology are listed for 1959. Twenty-four theses on New York geology are included in the 1959 supplement. Two small maps have been included in this report - one shows the status of mapping in the state up to 1960, and the other is a generalized geologic map of New York.--L. M. Dane.

**2-1025.** Robinson, Arthur H. **ELEMENTS OF CARTOGRAPHY: 2d ed., 343 p., 238 figs. incl. illus., maps, charts, diags., graphs, 43 tables, New York, John Wiley & Sons, 1960, 118 refs.**

Since the preparation of the manuscript for the first edition, about 7 years ago, many changes have occurred which affect the art and science of cartography. Perhaps the most significant has been a continuation of the recent expansion of interest in cartography and in area analysis in all fields. Cartography has continued to develop rapidly, both as a research technique and as a tool of presentation.

The importance of perceiving, describing, and understanding areal distributions and the significance of their interrelationships has spread to other disciplines, and they too are finding the map a most useful analytical and descriptive tool. This second edition has been prepared with this in mind.

Two other recent major developments in cartography are 1) the rapid growth of techniques for the gathering and processing of areal data ranging from the electronic to the statistical, and 2) the considerable advance in the technology concerning the preparation of material for reproduction. The primary process of cartography - the conceptual planning and designing of the map as a medium for communication or research - is still the fundamental aim of this edition.

A great many changes and additions have been made. Most of the text has been rewritten and over seventy new illustrations have been added; a few hav been deleted. New material has been incorporated in major proportion in several places. The most inadequate section of the first edition turned out to be that dealing with the symbolization and representation of the mapped data. Accordingly, this has been expanded from one to three chapters, completely reorganized and some of the elementary statistical concepts appropriate to the cartographic process have been included. Experience with the preceding edition also showed that the subject of map projection, so fundamental to cartography, needed fuller treatment. This section has been reorganized, incorporating a new introductory chapter treating the basic concepts involved in the projectional transformation of the spherical surface to a plane. It has been kept essentially nonmathematical. The author has also attempted to include the major developments in technology which affect the planning and execution of smaller-scale "geographic maps," without going into great detail concerning mechanica aspects. Among considerable new material include in the appendixes is a table of common logarithms. This will make much easier the students' completio of exercise material that may be assigned from the text.--From auth. pref.

Contents:

The Art and Science of Cartography
The Earth and the System of Coordinates
Cartographic Drawing and Measuring Techniques
The Nature of Map Projections
The Employment of Map Projections
The Construction of Projections
The Map Base: Compilation and Generalization
Symbolizing and Processing Map Data
Mapping Quantitative Point, Line, and Area Data
Mapping Three-Dimensional Data
Mapping the Terrain
Designing the Map
Lettering the Map
Map Reproduction: Processes and Preparation of Drawings

Appendix:

Common Logarithms
Natural Trigonometric Functions
Squares, Cubes, and Roots
Geographical Tables
Lambert Projection Tables
Stereographic Projection Tables
Lettering Magnification Tables
Tabular Aid to Consistency When Estimating Values of Fractional Areas
Proof of Tissot's Law of Deformation

**2-1026.** Troxel, Bennie W. **MAPS USED IN MINERAL INVESTIGATIONS: California, Div. Mines, Mineral Inf. Service, v. 13, no. 2, p. 1-13, 2 illus 7 maps, diags., table, Feb. 1960, 17 refs.**

Topographic, geologic, and mine maps are described for the layman. Planimetric maps and vert cal aerial photographs are described briefly; topographic maps are described in moderate detail. Ma scales, marginal information, map accuracy, and topographic map series are discussed, and a summary of the U. S. and California cooperative topographic mapping program is presented. Types and scales of topographic maps are compared, and sources of maps of California are tabulated.--Auth.

**2-1027.** Belcher, Donald J. **MICROFORMS AND**

EATURES: Photogramm. Eng., v. 25, no. 5, p. 3-778, Dec. 1959, ref.; abs. in English & German.

Micro-features are described as minor details of e earth's surface, seen in aerial photographs ich are either too small or too subtle to be noted normal mapping practice. They include micro- lief (changes in elevation of less than contour in- rval), as well as changes in tones, drainage, and getative patterns. Micro-features, properly ana- zed, provide a wealth of information as to the entification of bedrock, the determination of soil aterials and geologic structural relationships. The e of color photography raises the level of visibility many micro-features, and brings them into the alm of recognition for use in many types of ana- tical studies.--Auth.

1028. Colwell, Robert N. **THE FUTURE FOR HOTOGRAMMETRY AND PHOTO INTERPRETA- ION:** Photogramm. Eng. v. 25, no. 5, p. 712-736, rt., 16 illus., 6 stereograms, 7 diags., Dec. 1959, refs.

The next 25 years will bring better understanding the fact that photogrammetry and photo interpreta- on are not distinct fields, but closely related tech- ques. Advances in the areas of image quality, uipment and techniques, and aptitude testing for oto users will pace future developments in photo- rammetry and photo interpretation.

Image quality is primarily governed by 3 factors: the photographic tone or color contrasts between object and its background, 2) image sharpness aracteristics, and 3) stereoscopic parallax char- cteristics. The biggest improvement in tone con- ast will probably result from the more intelligent election of photographic films and filters. Optimum mbinations of finer grain film and long focal-length nses may provide improved sharpness characteris- cs. Stereobar camera mountings and the use of adow parallax may lead to improved stereoscopic rallax characteristics for low- and high-altitude otography respectively.

Improvements in film, cameras, photogrammetric otting devices, and the development of specialized uipment for particular jobs of photo interpretation ll pace future advances in the field of equipment d techniques.

Human beings still will be required to do much of e interpretation and mapping from aerial photo- aphs in the foreseeable future. However, the lection of people for training in photo interpretation d photogrammetry will probably be based on well- nstructed aptitude tests. Among other factors, ese tests will measure visual acuity for tone or lor contrast, sharpness, and stereoscopic parallax photographs of test targets.

Satellite photography of the earth and other planets ll open new horizons to the photogrammetrist and oto interpreter.--J. R. Van Lopik.

1029. Ray, Richard G., and William A. Fischer. **UANTITATIVE PHOTOGRAPHY - A GEOLOGIC ESEARCH TOOL:** Photogramm. Eng., v. 26, no. p. 143-150, 5 illus., 7 graphs, March 1960, 9 fs.

Various measurements useful in geologic research ay be made from aerial photographs. These meas- ements include not only height and distance deter- inations that relate to the common meaning of the rm photogrammetry but in addition involve color- eter and densitometer measurements, all of which are herein grouped under the term quantitative photography. This paper reports briefly on techniques of obtaining quantitative data from aerial photographs, on some results of data collection, and on possible uses of quantitative photography in geologic research.--Auth.

2-1030. Prusok, Rudi A., and John R. Ege. **A SIMPLE STEREOPHOTOGRAPHIC FIELD METHOD OF ROCK OUTCROP DESCRIPTION FOR THE GEOLOGIST:** Photogramm. Eng., v. 26, no. 1, p. 98-100, 2 illus., March 1960.

The use of stereophotographs for the study of rock outcrop descriptions can be employed by the field geologist utilizing an ordinary hand camera, an army field-type stereoscope, and a simple photographic procedure. The results give a 3-dimensional record of stratigraphic structures which can be studied later in the office.--Auth.

2-1031. Blake, Paul. **PHOTOGRAMMETRIC MAPPING OF THE BROOKS RANGE:** Photogramm. Eng., v. 25, no. 5, p. 679-685, port., 5 illus., map, Dec. 1959, ref.

This paper briefly reviews the background requirements for 1:250,000 scale maps in the Brooks Range area of Alaska; the problems that were faced in the initial planning of the job, and a detailed description of the photogrammetric operations in the Denver Office of the Geological Survey, with particular emphasis on the vertical and horizontal stereotriangulation problems.--Auth

2-1032. Wright, Marshall S., Jr. **PHOTOGEOLOGY GIVING RAPID COVERAGE IN FOUR CORNERS:** World Oil, v. 150, no. 2, p. 104-107, port., 2 maps, Feb. 1960.

"Geologic interpretation of aerial photographs is an effective means of evaluating large areas in the Four Corners region [New Mexico, Arizona, Utah, and Colorado], as well as many other oil-prospective districts of the world." Color photography has many advantages as it brings out information which otherwise would be overlooked. The sparse vegetation, prominent outcrops, and marked drainage give this method maximum advantages here. Three types of study are used: reconnaissance geomorphic, reconnaissance structural, and detailed photogeologic. The first uses drainage patterns, soil characteristics, and outcrops; the second uses strike and dips, faults and fractures, and structural axes; and the third uses those above plus formational boundaries, key beds, and all cultural features.--K. M. Willson.

2-1033. Minard, James P. COLOR AERIAL PHOTOGRAPHS FACILITATE GEOLOGIC MAPPING ON THE ATLANTIC COASTAL PLAIN OF NEW JERSEY. Photogramm. Eng., v. 26, no. 1, p. 112-116, illus., map, sec., diag., March 1960.

Color aerial photographs were used in the geologic mapping of the Pemberton, New Jersey, 7 1/2-min. quadrangle. The photographs were taken by Aero Service Corp. in late spring 1958, at scales of 1:12,000, 1:17,000, and 1:24,000. The quadrangle is underlain by essentially unconsolidated formations of Upper Cretaceous, Tertiary, and Quaternary age.

Color aerial photographs have specific advantages over black-and-white aerial photographs for mapping certain geologic features in this area. Interpretation of color aerial photographs resulted in obtaining geologic information in addition to that obtained from the interpretation of black-and-white aerial photographs. Interpretation of color aerial photographs particularly facilitated mapping 2 formational contacts which were extremely difficult to locate other than by extensive augering.--Auth.

**2-1034. ONE WORLD - THE NEW GEOLOGICAL CONCEPT: Oilweek, v. 10, no. 49, p. 15-35, Jan. 23, 1960.**

A digest of the 72 papers presented at the First International Symposium on Arctic Geology [Calgary, Alberta, Jan. 1960]. The digest ranges from an outline of the tectonic developments of the central Soviet Arctic to a method for accelerating the melting of ice and snow by artificial dusting. Also presented is Devonian stratigraphy in the Mackenzie River basin; the oil, mineral, and population potentials of the Canadian N.; and the geological interpretation of aeromagnetic profiles from the Canadian Arctic. Maps included.--Worldwide Oil & Gas Abstracts, v. 5, no. 1, p. 23, Jan.-Feb. 1960, abs. 51-8-18.

2-1035. New York (State), Bureau of Secondary Curriculum Development. **EARTH SCIENCE, AN OUTLINE OF TOPICS AND RELATED UNDERSTANDINGS FOR A COURSE OF STUDY: 44 p., chart, Albany, 1959.**

The syllabus outlines a course of study in earth science, developed from recommendations by the Science Advisory Committee and the Earth Science Syllabus Committee. The topical outline to be followed is given in a left-hand column and related understandings in a right-hand column. The following schedule is suggested for allocating teaching time and indicating relative emphasis of the 7 major topics: the earth's surface, 4 weeks; destructional forces, 6 weeks; constructional forces, 4 weeks; age of the earth, 2 weeks; the earth in space, 6 weeks; the atmosphere, 5 weeks; and airmasses and fronts, 5 weeks.--M. Russell.

2-1036. American Geological Institute. **SURVEY OF GEOLOGY-GEOPHYSICS STUDENTS IN THE COLLEGES AND UNIVERSITIES OF THE UNITED STATES AND CANADA IN 1958-59: Its: Rept. 12, 1959 ed., 23 p., 2 graphs, 2 tables, 1959, refs.**

This report of students enrolled in the geosciences covers graduate and undergraduate levels in the United States and Canada for the academic year 1958-1959. Pt. 1 is the survey of student enrollment, and Pt. 2 lists information on financial aid to students of geology-geophysics. A total of 238 colleges reported 11,085 students majoring in geology-geophysics. About 70% of the students are undergraduates, 20% are in the M. A. program and 10% in the Ph. D. program. Compared with earlier surveys, a continuing upward trend in percentages of students going for the Ph. D. is noted. Enrollment at the Master's level is stable, while there is a noticeable drop at the Senio level and a sharp drop at the Junior year level. A rise in the proportion of students majoring in geophysics is evident.--M. Russell.

**2-1037. RATIOS OF STUDENTS TO FACULTY: GeoTimes, v. 4, no. 6, p. 22-23, 4 maps, 2 tables March 1960, refs.**

The ratio of geoscience students, junior through graduate, to faculty in the United States ranges fron 5.1 for private New England schools to 12.3 for publ West South-Central schools; the average is 8. In Canada the average is 7.8. Charts show for the U. S. percentage distribution of geoscientists by region of employment; average number of geoscienc students per faculty member in departments offerin the Ph. D. degree, in departments offering the Master's degree, and in departments offering only the undergraduate degree.--M. Russell.

2-1038. Griffiths, John C. **ASPECTS OF MEASUREMENT IN THE GEOSCIENCES: Mineral Industries, v. 29, no. 4, p. 1, 4-5, 8, 3 figs. incl. illus Jan. 1960, 21 refs.**

Analytical procedures in the geosciences are tending toward greater rigor, and quantification is one step in this evolutionary trend. This article is a review of "measurement" and what such a development requires in order that the procedures may achieve the maximum level of information.

Measurement is defined as mapping observations onto numerals according to specific rules, and different "rules" lead to different scales or levels of information. Four such levels, nominal, ordinal, interval, and ratio scales are discussed, and examples of these scales, resulting from analytical procedures commonly used in the geosciences, are given. The scale achieved by the data from some analytical procedure determines the kind of data processing which is permissible and acts as a guide to the choice of appropriate statistical analysis.

As an example, conventional stratigraphic arran ment is shown to achieve ordinal level whereas radioactive decay rates lead to age measurement or at least an interval scale. It is important to emphasize that quantification procedure is invariant across all scales of magnitude included in the geosciences. --Auth.

2-1039. Scheidegger, Adrian E. **MATHEMATICA METHODS IN GEOLOGY: Am. Jour. Sci., v. 258, no. 3, p. 218-221, March 1960, 4 refs.**

An analysis is made of the various possible methods of investigation in the earth sciences. It is shown that, whereas much effort has been directed toward the observation of data, the theoretical analysis of these data and that of the intuitive inference gained therefrom has been somewhat lacking. Hope is expressed that mathematical analysis will becom of age in the earth sciences as it has in other disciplines.--Auth.

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